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Proceedings of 3rd Jožef Stefan International Postgraduate School Students Conference

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Part II.

25. maj 2011, Ljubljana, Slovenija

Zbornik 3. Študentske konference Mednarodne podiplomske šole Jožefa Stefana
(Proceedings of the 3rd Jožef Stefan International Postgraduate School Students Conference)

Uredniki:
Dejan Petelin
Aleš Tavčar
Brigita Rožič
Bogdan Pogorelc

Priprava zbornika:
Dejan Petelin

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**3. ŠTUDENTSKA KONFERENCA
MEDNARODNE PODIPLOMSKE ŠOLE
JOŽEFA STEFANA**

**3rd JOŽEF STEFAN INTERNATIONAL POSTGRADUATE SCHOOL
STUDENTS CONFERENCE**

Zbornik - 2. del

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Dejan Petelin

Aleš Tavčar

Brigita Rožič

Bogdan Pogorelc

Miha Mlakar

Violeta Mirchevska

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Ekotehnologija (Ecotechnology)

Določanje vsebnosti steroidnih estrogenov v odpadnih vodah brez predhodne ekstrakcije vzorcev

Miha Avberšek^{1,2}, Bojana Žegura³, Metka Filipič³, Ester Heath^{1,2}

¹ Odsek za znanosti o okolju, Institut Jožef Stefan, Ljubljana, Slovenija

² Mednarodna podiplomska šola Jožefa Stefana, Ljubljana, Slovenija

³ Nacionalni institut za biologijo, Ljubljana, Slovenija

miha.avbersek@ijs.si

V Skupini za organsko analizo Odseka za znanosti o okolju se ukvarjamo z raziskovanjem prisotnosti organskih onesnažil (npr. zdravila in hormoni) v okoljskih vzorcih. Proučujemo njihov izvor (kje nastanejo), kroženje (kako potujejo) in vpliv na ekosistem (kakšen je njihov dejanski učinek). Zgoraj opisana študija je del širšega projekta (v sodelovanju z Nacionalnim inštitutom za biologijo), ki proučuje steroidne estrogene (hormone) in druge spojine, ki povzročajo motnje človeškega in živalskega hormonskega sistema. Steroidni estrogeni so pogosto prisotni v odpadnih vodah komunalnih čistilnih naprav in v površinskih vodah, kamor se odpadne vode iztekajo. Čeprav so naravnega izvora, njihova prisotnost v okolju povzroča negativne učinke na živih organizmih (motnje v rasti in razvoju osebkov). Cilj te študije je razviti metodo, ki bo omogočala hitro zaznavanje teh spojin v okolju in zagotavljala učinkovito proučevanje njihove (negativne) vloge v ekosistemu. Ker so koncentracije steroidnih estrogenov v vzorcih zelo majhne (ng/L) je potrebno spojine v vzorcih koncentrirati z zamudnimi postopki. V naši študiji smo uporabili ER-Calux® test, ki smo ga prilagodili tako, da omogoča neposredno testiranje vzorcev, brez predhodne obdelave, pri čemer postopek skrajšamo iz nekaj ur na nekaj minut. Hkrati ohranimo zmožnost zaznavanja dovolj nizkih koncentracij, ki so običajne v okoljskih vzorcih. Ta test omogoča izvedbo hitrih presejalnih testov in posledično hitrejšo in cenejšo oceno tveganja, ki ga povzročajo steroidni estrogeni v okolju.



Določanje vsebnosti steroidnih estrogenov v odpadnih vodah brez predhodne ekstrakcije vzorcev

Miha Avberšek¹, Bojana Žegura², Metka Filipič², Ester Heath¹ (mentor)

¹Institut Jožef Stefan; Mednarodna podiplomska šola Jožefa Stefana; Smer: Ekotehnologija; miha.avbersek@ijs.si



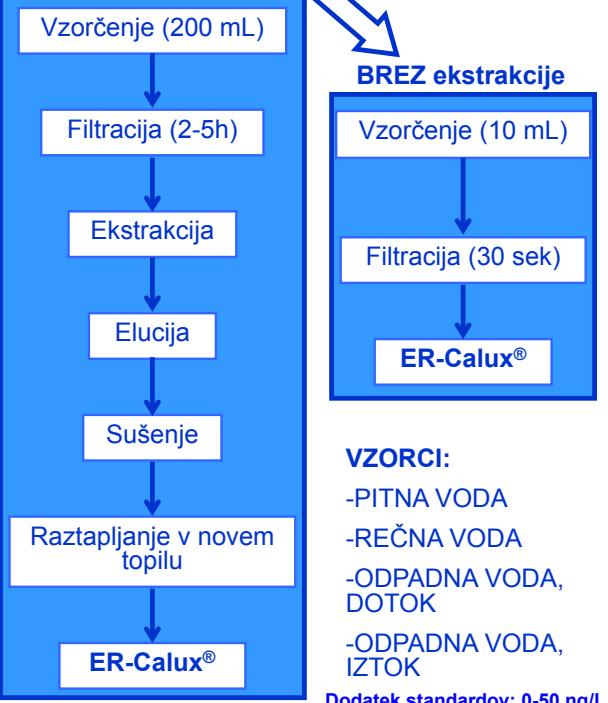
UVOD

²Nacionalni inštitut za biologijo

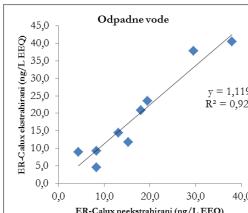
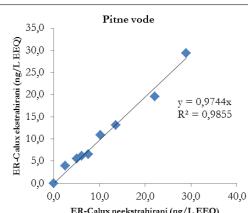
Steroidni estrogeni (estrone (E1), 17 β -estradiol (E2), estriol (E3) in 17 α -etinilestradiol (EE2)) so organska onesnažila, ki so pogosto prisotna v odpadnih vodah komunalnih čistilnih naprav in vodnem ekosistemuh, kamor se te vode stekajo. So večinoma naravnega izvora in lahko negativno vplivajo na organizme v okolju. Prisotnost steroidnih estrogenov so dokazali že v mnogih študijah. Zaradi nizkih koncentracij (ng/L) so za določanje njihove prisotnosti potrebne občutljive kemijske in biološke metode. Tako kemijske kot tudi biološke metode zahtevajo dolgotrajno pripravo in predhodno ekstrakcijo vzorca. Cilj raziskave je bil, da z uporabo in prilagoditvijo ER-Calux® testa razvijemo postopek, ki bi omogočal testiranje okoljskih vzorcev, predvsem odpadnih vod, brez predhodne ekstrakcije spojin. Metodo smo optimizirali in uporabili na realnih vzorcih.

Metode in materiali

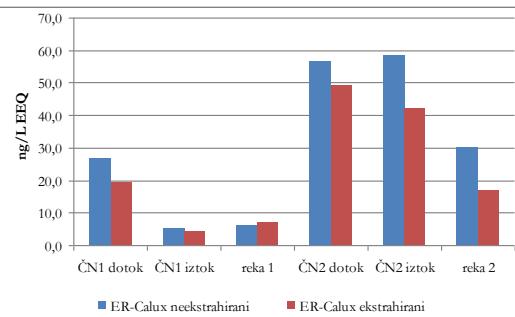
Z ekstrakcijo



Rezultati



Slika 1: Primerjava rezultatov ekstrahiranih in neekstrahiranih vzorcev pitne in odpadne vode z dodanimi standardi



Slika 2: Primerjava rezultatov neekstrahiranih in ekstrahiranih vzorcev dotokov in iztokov iz dveh komunalnih čistilnih naprav ter rek, v katere se iztoka izlivata.

UPORABNOST V PRAKSI

Hitro in učinkovito zaznavanje prisotnosti steroidnih estrogenov je ključno pri oceni tveganja, ki ga povzroča prisotnost teh spojin v okoljskih vzorcih. V okviru naše raziskave smo razvili postopek, s katerim lahko estrogenost vzorcev določamo brez predhodne ekstrakcije in se tako izognemo zamudni pripravi vzorcev. Rezultati testiranja vzorcev brez predhodne ekstrakcije so primerljivi z običajno metodo, kjer je potrebno vzorce predhodno ekstrahirati. Prednost in uporabnost postopka je predvsem v tem, da hitreje pridemo do želenih rezultatov, kar omogoča hitre presejalne teste in izvajanje nadzornih meritev ter istočasno prihrani tudi material.

Oxygen breathing manipulations for enhancing erythropoietin production

Tadej Debevec^{1,2}, Igor B. Mekjavić¹

¹ Department of Automation, Bicybernetics and Robotics, Jozef Stefan Institute, Ljubljana, Slovenia

² Jozef Stefan International Postgraduate School, Ljubljana, Slovenia

tadej.debevec@ijs.si; SUPERVISOR: Prof. Igor B. Mekjavić

This paper presents one of a series of studies investigating the physiological consequences of manipulating oxygen partial pressure in the inspired air. The studies conducted during the course of my PhD training mainly dealt with the effects of simulated altitude exposure or training in simulated altitude on subsequent sports performance. Hypoxia (lower oxygen levels) or hyperoxia (higher oxygen levels) are nowadays extensively used in sports and medicine to enhance human performance and alleviate or treat respiratory and haematological medical disorders, respectively. The main aims of the studies were to investigate the effects of short protocols employing intermittent or chronic hypoxia on selected physiological indexes that could prove beneficial for sports and medical use. Our findings have shown that some benefits (e.g. certain adaptation to hypoxic environment, enhancement of performance at altitude) can be expected following short intermittent hypoxic protocols, but a certain threshold has to be surpassed if the beneficial adaptations are to be expected. The physiologically applied nature of the described work does not exclude the possible applicability of our work to industry. Moreover, even if our studies are mainly oriented to investigate the selected human physiological mechanism and effect, their possible applications cover a range of clinical, health and sports related fields. The investigated protocols, if proved efficient, could be applied to hospital environments and health or sports related practices with the involvement of industrial partners concerned in medical equipment production and development. In particular, the studies directed by prof. Igor B. Mekjavić have already led to a fruitful collaboration with a foreign industrial partner that is now becoming one of the main European producers of altitude training simulation systems and facilities (b-Cat, The Netherlands).



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OXYGEN BREATHING MANIPULATIONS FOR ENHANCING ERYTHROPOIETIN PRODUCTION



TADEJ DEBEVEC
Ecotechnology
Mentor: prof. IGOR B. MEKJAVIĆ
Department of Automation, Biocybernetics and Robotics
"Jozef Stefan" Institute, Ljubljana, Slovenia



RATIONALE

- HEMATOLOGICAL EFFECTS OF HYPOXIA AND HYPEROXIA
- HYPOXIA ↑ ERYTHROPOIETIN
- HYPEROXIA ↓ ERYTHROPOIETIN
- COMPLEX REGULATION OF EPO
- SUBSEQUENT HYPOXIA & HYPEROXIA ?
- PARADOXICAL FINDINGS

BACKGROUND

- MANIPULATION OF OXYGEN CONTENT
- SIGNIFICANT PHYSIOLOGICAL EFFECT
- DETRIMENTAL & BENEFICIAL
- HYPOXIC TRAINING MODALITIES
- HEMATOLOGICAL ADAPTATIONS
- IMPORTANCE OF THE ΔPO_2

HYPOTHESIS AND BASIC STUDY CHARACTERISTICS

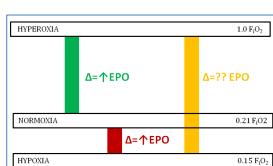


Fig. 1 Potential effects of changes in F_1O_2 on Erythropoietin (EPO) production

- BLINDED, PLACEBO CONTROLLED RANDOMIZED STUDY DESIGN
- TWO GROUPS OF SUBJECTS CON ($n=8$) & IHH ($n=10$)
- 9 [EPO] MEASUREMENTS ELISA (sandwich enzyme-linked immunoassay)
- TWO WAY ANOVA ANALYSIS (group x sampling periods)

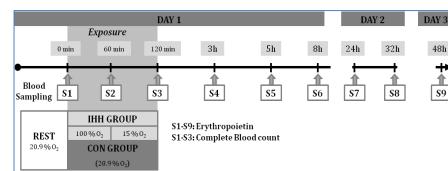


Fig. 2 Schematic outline of the study protocol and sampling periods

THE AIM WAS TO INVESTIGATE THE EFFECT OF COMBINED HYPOXIA AND SUBSEQUENT HYPEROXIA ON EPO PRODUCTION

RESULTS AND DISCUSSION

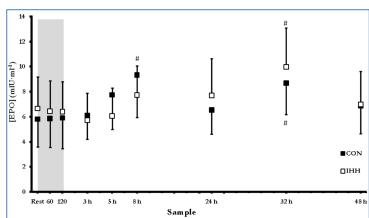


Fig. 3 Absolute EPO values in both groups

- No differences in [EPO] between groups
- Changes in [EPO] within groups
- Differences in Δ [EPO] between groups
- IHH induced a transient decrease in [EPO]

- IHH does not augment EPO *de novo* production
- ΔPO_2 does not seem to be important above hypoxic threshold

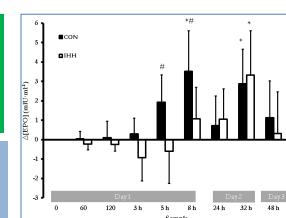


Fig. 4 Relative EPO values in both groups

APPLICABILITY

MEDICINE

- CHEAPER ALTERNATIVE TO rHu EPO
- TREATMENT OF ANEMIAS
- ADJUNCT THERAPY FOR CANCER PATIENTS
- RESPIRATORY DISORDER TREATMENT

SPORT SCIENCE

- IMPROVED EFFICIENCY OF HYPOXIC TRAINING PROTOCOLS
- ENHANCED OXYGEN FLUX AND SUBSEQUENT ENHANCED PERFORMANCE
- MINOR DISTURBANCE TO THE TRAINING PROGRAMS

INDUSTRY

- CONNECTING PHYSIOLOGY TO MEDICAL EQUIPMENT PRODUCTION
- TECHNOLOGY FOR HYPOXIC AND HYPEROXIC CONDITIONS
- MEDICAL EQUIPMENT DEVELOPMENTAL IDEAS

tadej.debevec@ijs.si

Plasma sterilization as a key for cleaning delicate materials

Kristina Eleršič^{1,2}, Miran Mozetič^{1*}

¹ Department of F4, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

kristina.elersic@ijs.si

Applying sterile material in many applications can have several difficulties; one of these is unstable material which can be damaged during the sterilization processes, for example melted in autoclave. For this reason, developers are trying to make sterile surfaces by making simple and environmental friendly processes of sterilization. One of very promising methods is plasma treatment of surfaces. We are trying to use weakly ionised plasma which has a low temperature and has specially adapted properties. In our experimental work, we sterilize materials, which are usually destroyed during normal disinfection processes such as polymers and polymer composites. Using plasma in the procedure can create clean surfaces and help reusing materials which will be a huge step for the environment. Investigation also includes degradation steps of bacteria *Escherichia coli*. This bacterium is one of the most investigated bacteria in biochemistry and also plays important role in infections due to many pathogens from their strain. By applying reactive plasma we can destroy bacteria and remove dust on the surface but leave the material almost intact.



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Plasma sterilization as a key to cleaning delicate materials

KRISTINA ELERŠIČ, univ. dipl. kem.
Mednarodna podiplomska šola Jožefa Stefana
MENTOR: doc. dr. MIRAN MOZETIČ
SOMENTOR: doc. dr. UROŠ CVELBAR
Inštitut Jožef Stefan,
Jamova cesta 39,
1000 Ljubljana

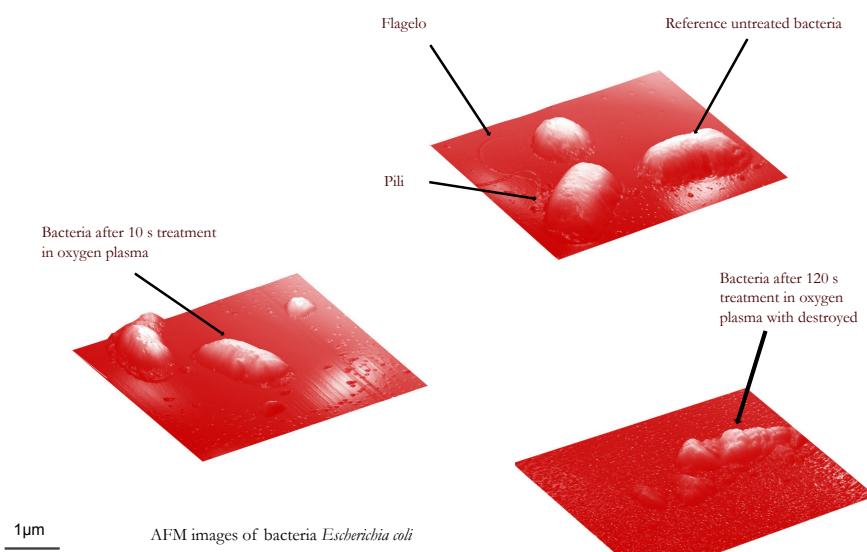


THEORETICAL BACKGROUND

Outbreaks of diseases resulting from infection by pathogenic microorganisms like E.coli, greatly disrupt daily life and constitute significant health problem. The materials and components should therefore be sterilized occasionally. Steam, heat, UV and chemical sterilization seems to be not sufficient techniques to fight against microorganisms. In finding another solution, the idea is to destroy microorganisms with physical methods.

APPLICATION

Applying sterile environment and material in many applications can have several difficulties; one of those is unstable material which can be damaged during the sterilization processes, for example melted in autoclave.
By applying reactive plasma we can destroy bacteria and remove dust on the surface but leave the material almost intact.



Čiste premogovne tehnologije in project CoGasOUT

Jernej Lazar, Simon Zavšek, Sergej Jamnikar, Janja Žula, Gregor Urancik, Ludvik Golob

Premogovnik Velenje d.d., Partizanska 78, Velenje

jernej.lazar@rlv.si

Pomen premoga kot vir energije se v zadnjih letih ponovno povečuje. Prednosti pred drugimi energenti lahko iščemo v razvoju novih, ekološko bolj prijaznih tehnologij uporabe premoga, tako imenovanih čistih premogovnih tehnologij (ang: Clean Coal Technologies). Zato smo se na Premogovniku Velenje odločili ustanoviti projektno skupino Čiste premogovne tehnologije, ki bo razdeljena na tri projektne naloge: razplinjevanje lignitnega sloja, zajem, transport in shranjevanje CO₂ in na podzemno uplinjanje premoga. Julija 2010 smo začeli v okviru prve projektne naloge razplinjevanje lignitnega sloja z izvajanjem mednarodnega projekta CoGasOUT (Razvoj novih tehnologij za napoved in preprečevanje izbruhov plinov ter nenadzorovanih emisij v premogovnikih z debelimi in/ali strmimi sloji premoga). Od pričetka trajanja projekta smo izvedli program geotehničnih in plinskih meritev ter raziskav v jamskem okolju, obdelali smo pridobljene podatke ter jih povezali z dogodki, ko je zaradi odkopavanja prihajalo do povečanih volumnov premogovega plina.



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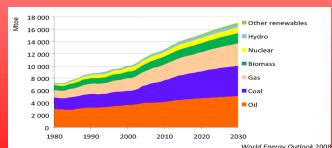
CLEAN COAL TECHNOLOGIES

Jerneja Lazar, Simon Zavšek, Sergej Jamnikar, Janja Žula, Gregor Uranjek, Ludvik Golob
Coal Mine Velenje, Partizanska 78, VELENJE, SLOVENIA

INTRODUCTION



- The importance of coal is growing again.**
- Global power demand will rise by 45% until 2030, with the average annual rise is estimated at 1.6%. The share of coal is one third of the entire growth.
- Coal-based power generation represents more than 40% of global energy production.
- Clean Coal Technologies (CCT) are tied to technological progress leading to more efficient and environmentally friendly coal consumption.
- According to long-term production plan of lignite in Velenje Coal Mine, projected to 2054 and presently assuring a 30% share of Slovenia's power production, we decided to found a project group Clean Coal Technologies at the end of 2007.



Energy production forecast till 2030 (reference scenario, IEA)

GAS DRAINAGE

PROJECT: Development of novel technologies for predicting and combating gas outbursts and uncontrolled emissions in thick seam coal

To develop and test new and novel technologies for the assessment, prediction, prevention and risk management of gas outbursts and uncontrolled gas emissions in coal mines which operate in thick and/or steeply dipping thick seams.

Application: RFCS

Acronym: CoGasOUT

Label: RFCS-PR-08022

VCM share: 17%

Duration: 3 years

Call: 15.9.2009

Start: 1.7.2010

Coordinator: Imperial College London(UK)

Project Partners:

Velenje Coal Mine (Slovenia)

K-UETC, DMT (Germany)

RMSL (UK)

AITEMIN, HVL (Spain)

GIG (Poland)

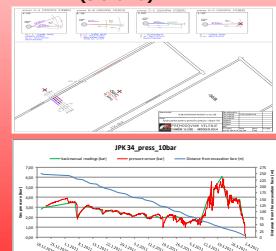
HBP (Slovakia)

Project performance in 2011:

- Seam gas composition in horizontal boreholes (3m and 25m long).
- Seam gas pressure and stress.
- Laboratory isotopic analysis and gas origin estimates.

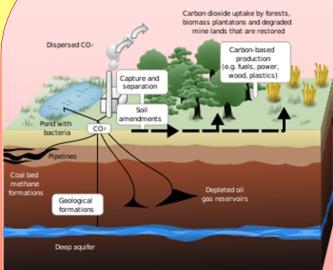


Gas composition change with respect to distance from the longwall face (3m long borehole in Pešje K-50/B)



Gas pressure change in the long borehole (25m) in dependence from advancing excavation face in the coal pillar

CO₂ CAPTURE, TRANSPORT AND STORAGE (CCS)



- Alleviation of the contribution of fossil fuel emissions to global warming, based on capturing carbon dioxide from large sources such as fossil fuel power plants, and storing it in such a way that it does not enter the atmosphere.
- In Germany, the plans for pilot and demonstration CCS projects are ready and some of them are already running.

Implementation of the Climate-Energy Packages in Slovene Power Supply (ZETe-PO)

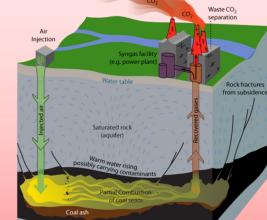
- PR 1 Carbon Capture Technologies.
- PR 2 Geological Storage of CO₂ - potential locations in Slovenia.
- PR 3 Implementation of CCS EU legislation into Slovene law.



UNDERGROUND COAL GASIFICATION (UGC)

Underground coal gasification is an unconventional type of coal utilization.

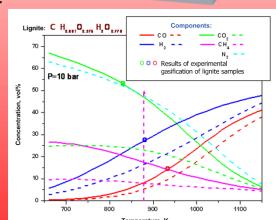
Procedure:
Through the injection well, air and steam are brought under pressure into coal seam where the combustion begins. The product is syngas with main components hydrogen and carbon monoxide.



Economic advantages:
Minor operating costs of UGC use (no excavation costs, transport costs, fly ash depositing,...); Major flexibility of syngas use.

Environmental advantages:
Most ashes remains underground, minor emissions of heavy metals, SOX; Minor CO₂ emissions.

In case of UGC, at Velenje Coal Mine, the task force has been revived and the feasibility study continued. The activities will run to prepare the proposal of project task for pilot UGC test in Velenje and to gain concession for research of coal in Goričko (Slovenia).



The temperature dependence of equilibrium concentrations of gases in the gasification of lignite in a stream of oxygen and air

FEELING FOR THE FUTURE

TEMPERATURNI IN VLAŽNOSTNI PROFILI V RAZLIČNIH GRADBENIH SKLOPIH PASIVNIH HIŠ

Jana Mlakar^{1,2,3}, Janez Štrancar^{2,3}

¹Eko produkt d.o.o., Ljubljana

²Odsek za fiziko trdne snovi, Inštitut Jožef Stefan, Ljubljana, Slovenija

³Mednarodna podiplomska šola Jožef Stefan, Ljubljana, Slovenija

jana@ekoprodukt.si

Notranji bivalni pogoji močno vplivajo na udobje in zdravje njihovih prebivalcev. Uporaba neprimernih gradbenih materialov in neprimerna izvedba gradnje lahko povzročita bolezni in celo trajne poškodbe njihovih prebivalcev, zato je potrebno ohranjati temperaturo in vlogo v optimalnem območju (20°C - 26°C , 30 - 60 %), s čim manjšimi nihanji. Raziskave nakazujejo, da bivalno okolje v hišah lahko uravnamo z izborom ustreznih gradbenih materialov, ki znižajo nihanja temperature in vlage ter ju ohranjajo v optimalnem območju. Tako je o bivalnih pogojih potrebno razmišljati že pri načrtovanju pasivne hiše.

Z raziskavami v okviru projekta, ki ga delno financira Evropska unija, Evropski socialni sklad, želimo nakazati, kako uporaba pravilnih materialov prispeva k boljši kvaliteti bivanja v pasivnih hišah.

V ta namen smo izdelali testne objekte manjših dimenzijs v pasivnem standardu z različnimi sestavami sten in strehe, v katerih spremljamo temperaturo in relativno vlažnost na različnih mestih. Temperaturo in vlogo na različnih mestih v steni spremljamo tudi na delajočih hišah. Na tesnih objektih merimo kako različni gradbeni materiali, ki se razlikujejo v toplotni kapaciteti in toplotni prevodnosti (predvsem celulozna izolacija in leseno vlaknene plošče v primerjavi s stekleno volno in polistirenom) vplivajo na temperaturo in relativno vlažnost v pasivnih hišah. Z raziskavami želimo preveriti hipotezo, da večja toplotna kapaciteta materialov zmanjša temperturna nihanja, da vgradnja različnih materialov na osnovi lesa še dodatno zmanjšuje oscilacije relativne vlažnosti v prostoru ter kako zmore ovoj hiš držati zračno vlogo v območju med 40% in 60%.

Poleg tega v eni od delajočih hiš spremljamo delovanje vseh sistemov v hiši (ogrevanje, prezračevanje, dobitki sončne energije), s čimer lahko analiziramo celotno energijsko ravnovesje v hiši. Tako lahko opazujemo različne pojave v hiši ter z modeliranjem energijskega ravnovesja poiščemo preproste rešitve, ki preprečijo nezaželene pojave, npr. poletno pregrevanje hiše.

Rezultati raziskav bodo uporabni pri načrtovanju in optimizaciji pasivnih hiš. Z uporabo izsledkov raziskav bo mogoče načrtovati pasivne hiše, ki bodo omogočale še ugodnejše bivalne pogoje ter bodo hkrati manj obremenjevale okolje.



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TEMPERATURNI IN VLAŽNOSTNI PROFILI V RAZLIČNIH GRADBENIH SKLOPIH PASIVNIH HIŠ



Naložba v vašo prihodnost
OPERACIJSKO DELNO FINANCIRA EVROPSKA UNIJA
Evropski socialni sklad



Odsek za fiziko trdne snovi, Inštitut Jožef Stefan, Jamova 39, 1000 Ljubljana

JANA MLAKAR, univ. dipl. biol.
Študijski program: Ekotehnologija
Mednarodna podiplomska šola Jožefa Stefana
Raziskovalni mentor: izr. prof. dr. JANEZ ŠTRANCAR
Razvojni mentor: MIRKO ŠKVORC
Eko produkt d.o.o., Trpinčeva 39, 1000 Ljubljana

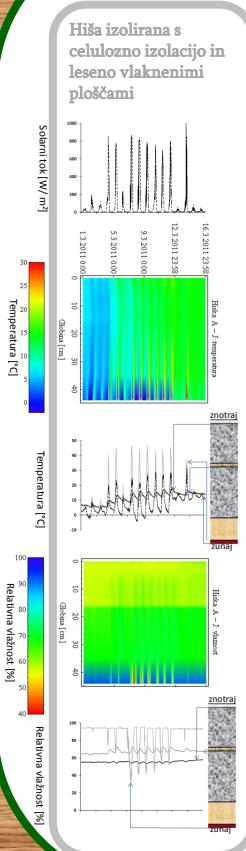


- ali prihaja v gradbenem sklopu do kondenzacije?
- kako materiali vplivajo na energijsko bilanso hiše?
- kako zagotovimo zdrave bivalne pogoje v hiši?
- kakšen je optimalen gradbeni sklop?
- kakšna je optimalna hiša?

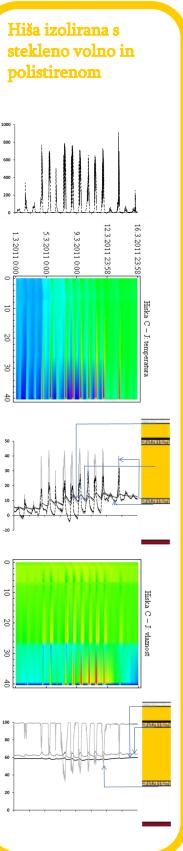
- kako poteka difuzija vodne pare?
- kako toplotna prevodnost, specifična toplotna kapaciteta, gostota, difuzijska upornost vodni pari, vlažnostna kapaciteta materialov vplivajo na temperaturne in vlažnostne profile v gradbenih sklopih ter na bivalne pogoje v hišah?

Časovno odvisni temperaturni in vlažnostni profili

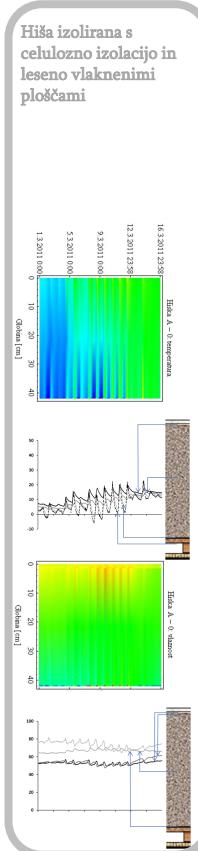
Južna stena



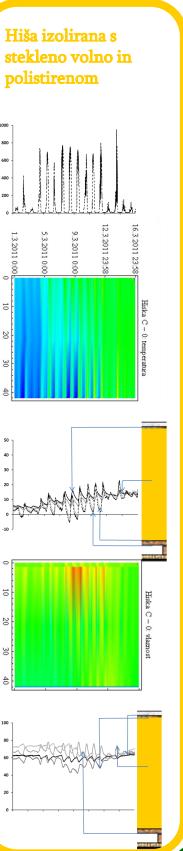
Hiša izolirana s stekleno volno in polistirenom



Streha



Hiša izolirana s stekleno volno in polistirenom



- izdelava treh manjših testnih objektov in merilnega sistema

- 89 temperaturnih senzorjev
- 95 vlažnostnih senzorjev
- 7 fotosenzorjev



- materiali z višjo specifično topotno kapaciteto in gostoto zvečajo fazni zamik prenosa toplotne in s tem tudi znižajo nihanja temperature
- materiali na osnovi lesa blažijo nihanja vlage

- pri načrtovanju in optimizaciji pasivnih hiš je pomembna izbira gradbenih materialov
- vgradnja materialov na osnovi lesa izboljša bivalne pogoje

Validation of the analytical procedure for preparation of stable Cr(VI) and Cr(III) isotopic standard solutions from ^{50}Cr and ^{53}Cr enriched oxides

Breda Novotnik^{1,2}

¹ Department of Environmental sciences, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

Supervisor: Assoc. Prof. Radmila Milačič

breda.novotnik@ijs.si

Chromium is a metal that is present in the environment from anthropogenic and nonanthropogenic sources. Because of the wide industrial use, it is a common contaminant in the environment. Chromium has different properties according to its oxidation state. Cr(VI) is toxic and Cr(III) is an essential micronutrient. Because of these different species properties, speciation studies are necessary where not total chromium, but the concentrations of different oxidation states, are measured. Chromium stable isotopic spikes can be used as tracers of processes in the environment. In the past, these spikes were inadequately prepared, using oxidizing and reducing agents in the procedure. In our study, a protocol was developed for preparation of stable isotopic spikes without any oxidizing and reducing agents. It was experimentally proven that such isotopic solutions are pure and that the use of oxidizing and reducing agents, as reported in previous studies [1-3], can cause artefacts in samples investigated.



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Validation of the analytical procedure for preparation of stable Cr(VI) and Cr(III) isotopic standard solutions from ^{50}Cr and ^{53}Cr enriched oxides

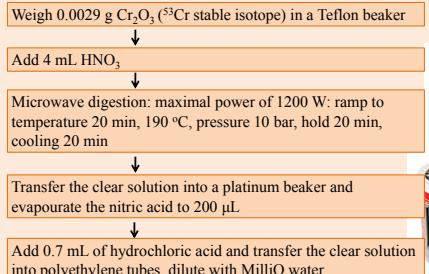
Introduction

Due to its wide industrial use, chromium is a common environmental pollutant. In the environment Cr exists in general in Cr(III) and Cr(VI) oxidation states. In speciation analysis, the enriched stable isotopes may be used as tracers to follow the oxidation-reduction processes, or to control the analytical procedures. For application of Cr enriched stable isotopes adequate preparation of isotopic spikes is necessary. Meaning that no excess of reducing neither oxidising agents should remain in the isotopic spike that would disturb the Cr speciation in the sample investigated. ^{50}Cr and ^{53}Cr enriched oxides are commonly available. Isotopic standard solutions are in general prepared with oxidizing and reducing agents such as hydrogen peroxide. The procedure is time consuming and the risk exists that in the isotopic spike solution the excess of hydrogen peroxide still remains. Such isotopic spike solution may possibly influence Cr speciation in the sample investigated. Therefore, the aim of the present study was the adequate preparation of Cr(VI) and Cr(III) stable isotopic spikes from ^{50}Cr and ^{53}Cr enriched oxides and to demonstrate that no oxidizing or reducing agents should be used in the preparation steps.

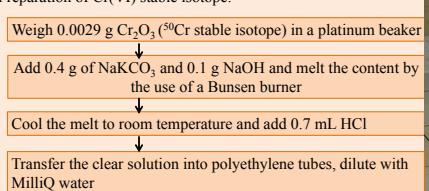
Materials and methods

Preparation of isotopic standard solutions from enriched stable isotopes

Preparation of Cr(III) stable isotope:



Preparation of Cr(VI) stable isotope:



FPLC-ICP-MS

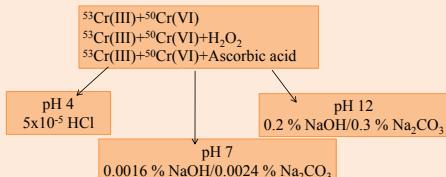
For separation of Cr(III) and Cr(VI) Mono Q™ 5/50 GL column was used. ICP-MS was running under High energy collision mode with parameters: RF power: 1550 W, carrier gas 0.64 L min⁻¹, dilution gas 0.53 L min⁻¹, He gas 10 mL min⁻¹



HPLC-ICP-MS

Influence of hydrogen peroxide and ascorbic acid on Cr speciation at environmental pH values

To study the influence of hydrogen peroxide and ascorbic acid on the oxidation-reduction processes, the mixture of Cr(III) and Cr(VI) isotopic spikes was prepared at environmental pH values (pH 4, pH 7 and pH 12) with the addition of 15 µg mL⁻¹ of hydrogen peroxide and 0.5 µg mL⁻¹ of ascorbic acid.



Breda Novotnik, Jožef Stefan International Postgraduate School, Ecotechnology
Supervisor: Assoc. prof. Radmila Milačić, Co-supervisor: Assoc. prof. Janez Ščančar

Results and discussion

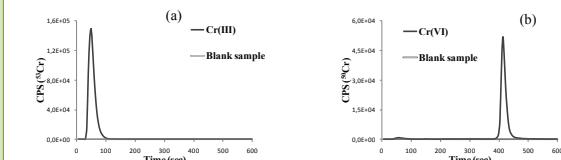


Figure 1: (a) Speciation of $^{53}\text{Cr}(\text{III})$ and (b) $^{50}\text{Cr}(\text{VI})$

Figure 1 clearly demonstrates that after the recommended protocol pure isotopic spikes are obtained.

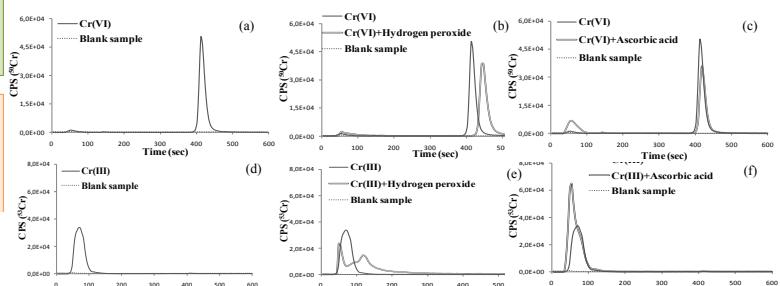


Figure 2: The influence of oxidising and reducing agents on speciation of Cr at pH 4: (a) ^{50}Cr , (b) $^{50}\text{Cr} + \text{H}_2\text{O}_2$, (c) $^{50}\text{Cr} + \text{ascorbic acid}$, (d) ^{53}Cr , (e) $^{53}\text{Cr} + \text{H}_2\text{O}_2$, (f) $^{53}\text{Cr} + \text{ascorbic acid}$

Data from Figure 2 indicates that presence of ascorbic acid can cause reduction of Cr(VI) at acidic pH, while it does not have a significant influence on speciation on Cr(III). It is further evident that the presence of hydrogen peroxide slightly influences Cr(III) speciation at acidic pH.

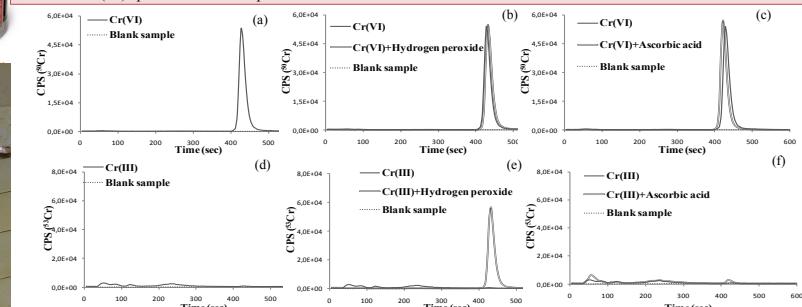


Figure 3: The influence of oxidising and reducing agents on speciation of Cr at pH 7: (a) ^{50}Cr , (b) $^{50}\text{Cr} + \text{H}_2\text{O}_2$, (c) $^{50}\text{Cr} + \text{ascorbic acid}$, (d) ^{53}Cr , (e) $^{53}\text{Cr} + \text{H}_2\text{O}_2$, (f) $^{53}\text{Cr} + \text{ascorbic acid}$

From Figure 3 it is evident that ascorbic acid has no effect on Cr(III) and Cr(VI) at pH 7, whereas hydrogen peroxide causes oxidation of Cr(III) (Figure 2e).

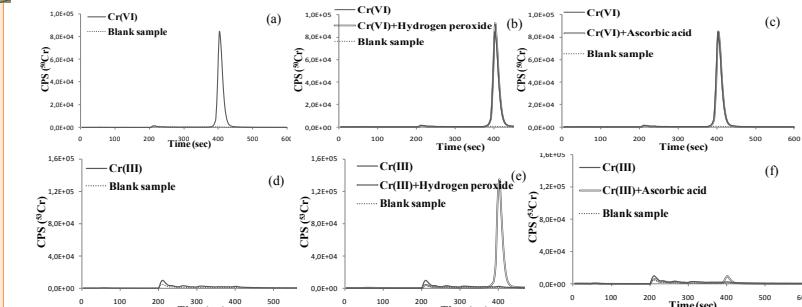


Figure 4: The influence of oxidising and reducing agents on speciation of Cr at pH 12: (a) ^{50}Cr , (b) $^{50}\text{Cr} + \text{H}_2\text{O}_2$, (c) $^{50}\text{Cr} + \text{ascorbic acid}$, (d) ^{53}Cr , (e) $^{53}\text{Cr} + \text{H}_2\text{O}_2$, (f) $^{53}\text{Cr} + \text{ascorbic acid}$

Data from Figure 4 indicates that ascorbic acid has no effect on speciation at pH 12, whereas hydrogen peroxide quantitatively oxidises Cr(III) at alkaline pH.

Conclusions

• Recommended procedure for preparation of isotopic standard solutions from enriched stable isotopes of chromium oxide gives pure isotopic solutions.

• It was experimentally proven, that residues of oxidizing or reducing agents in isotopic spike solutions could influence chromium speciation in the sample investigated.

• The results of present study reveal the importance of adequate preparation of stable Cr isotopes used in environmental studies.

Razvoj analiznega postopka za določanje celotnih koncentracij kroma v morski vodi z ICP-MS

Tina Oblak¹, Radmila Milačič¹, Janez Ščančar¹

¹ Odsek za znanosti o okolju, Inštitut Jožef Stefan, Ljubljana, Slovenija

Radmila.milacic@ijs.si

Masna spektrometrija z induktivno sklopljeno plazmo (ICP-MS) je zaradi hitre, multielementne analize in doseganja nizkih mej zaznave ena izmed vodilnih tehnik s področja določanja koncentracij elementov. Elementi se v morski vodi pojavljajo v sledovih. Zaradi visoke vsebnosti soli je njihovo direktno določanje z ICP-MS nezanesljivo.

Razvili smo analizni postopek, ki temelji na odstranitvi matrice morske vode z uporabo kelatno ionsko izmenjalne smole Chelex-100 in določitvi elementov z ICP-MS. Posebno pozornost smo posvetili kromu, ki ga do sedaj z omenjenim postopkom ni bilo mogoče določiti, ker se nahaja v vzorcih vod v dveh oksidacijskih stanjih. Trivalentna oblika kroma se veže na Chelex-100 smolo, šestivalentna, ki je prisotna v obliku negativnih anionov pa se na smolo ne veže. Specifična vezava kovin na smolo omogoča odstranitev matrice vzorca (glavne sestavine morske vode: Na^+ , K^+ , Ca^{2+} , Mg^{2+} , Cl^-) in sočasno predkoncentracijo kovin, ki jih določamo. Ker je v morski vodi poleg trivalentnega kroma prisoten tudi šestivalentni, smo vzorcu dodali dvovalentno železo, ki je šestivalentni krom reduciralo, celotni krom v trivalentni obliki pa se je nato vezal na kelatno smolo. Razvit analizni postopek smo uspešno uporabili pri analizi celotnih koncentracij kroma v realnih vzorcih morskih vod.



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RAZVOJ ANALIZNEGA POSTOPKA ZA DOLOČANJE CELOTNIH KONCENTRACIJ KROMA V MORSKI VODI Z ICP-MS

TINA OBLAK, univ. dipl. kem.

Študijski program: Ekotehnologija,
Mednarodna podiplomska šola Jožefa Stefana

MENTOR: izr.prof.dr. JANEZ ŠČANČAR

SOMENTOR: izr.prof.dr. RADMILA MILAČIČ

Inštitut Jožef Stefan, Jamova cesta 39, 1000 Ljubljana



Namen dela:

Razviti analizni postopek za direktno določanje celotne koncentracije kroma v morski vodi. Matrico smo odstranili s kelatno ionsko izmenjalno smolo Chelex-100 in krom določili z ICP-MS.

Morska voda:

- kovine se pojavljajo le v sledovih
- krom se pojavlja v dveh oksidacijskih stanjih (kation Cr(III) in anion Cr(VI))
- matrica z zelo kompleksno sestavo (možne interference Na⁺, Ca²⁺, Mg²⁺)

Chelex-100:

Kelatna ionsko izmenjevalna smola, ki specifično veže katione kovin v dvovalentni in trivalentni obliku. To omogoča odstranitev matrice vzorca in sočasno predkoncentracijo kovin, ki jih določamo.

Analizni postopek:

Vzorci: 4 realni vzorci morske vode Slovenskega primorja

1.Chelex-100 (Na⁺) smo pretvorili v NH₄⁺ obliko in napolnili v 1 mL kolone.

2.Vzorce morske vode smo redčili 1/5 in s HNO₃ nakisali na pH 2.

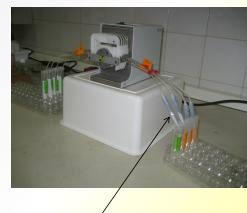
3.Dodali smo Fe(II), ki reducira Cr(VI) v Cr(III). Redukcija Cr(VI) je potekala 2 uri.

4.Po koncu redukcije smo vzorcem dodali 0,2 mol/L HEPES in dvignili pH na 4

5.Črpanje vzorcev skozi kolone s pretokom 0,5 mL/min

6.Spiranje vezanega Cr na smoli s 5 mL 3 mol/L HNO₃ pri pretoku 0,5 mL/min in nato še s 5 mL vode pri pretoku 2 mL/min.

7.Merjenje koncentracije Cr z ICP-MS



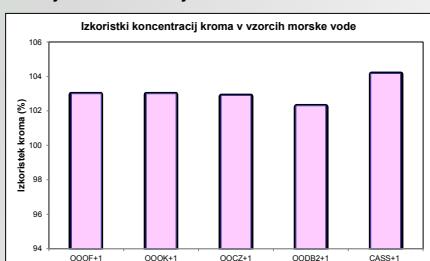
1 mL kolone napolnjene s
smolo Chelex-100

Rezultati:

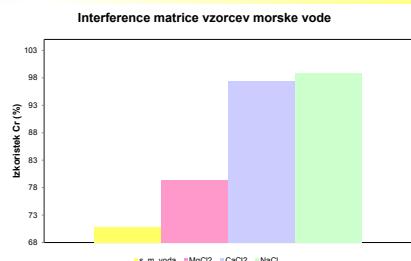
- Vzporedno z vzorci smo analizirali certificiran referenčni material CASS-5.
- Koncentracija Cr v vzorcih in CASS-5 so blizu meje zaznave ICP-MS, zato smo dodali 1 ng/mL Cr(VI) in izračunali izkoristke med dodano in izmerjeno vrednostjo.

Interference matrice morske vode:

- Sintetična morska voda
 - 3,8 % NaCl
 - 1500 µg/mL MgCl₂
 - 600 µg/mL CaCl₂
- Dodatek 1 ng/mL Cr(VI)



Ponovljivost analiznega postopka: RSD 2,5 %
Obnovljivost analiznega postopka: RSD 3,4 %



Kaže na točnost analiznega postopka

Zaključek:

Originalen in enostaven pristop, ki temelji na predhodni redukciji Cr(VI) in redčenju vzorcev morske vode pred postopkom kelatne ionske izmenjave, omogoča kvantitativno in zanesljivo določitev celotnega Cr v morski vodi z ICP-MS. Poleg Cr lahko v morski vodi kvantitativno določimo tudi druge dvovalentne in trivalentne katione. Z večjim volumenom prečrpanega vzorca skozi kolono lahko vzorec tudi koncentriramo.

Raziskave uporabnosti porcelanske črepinje pri pripravi gliničnega porcelana C-120

Helena Razpotnik^{1,3}, Ivan Lavrač¹, Janez Holc², Danjela Kuščer², mentor Marija Kosec²

¹ ETI Elektroelement d.d. Izlake, Slovenija

² Odsek za elektronsko keramiko, Inštitut Jožef Stefan, Ljubljana, Slovenija

³ Mednarodna podiplomska šola Jožefa Stefana (Ekotehnologija, 2.let)

helena.razpotnik@eti.si

Novi elektrotehnični izdelki so podvrženi vse večjim obremenitvam, kar zahteva uporabo materialov z nadstandardnimi karakteristikami. Pri gliničnih porcelanih se pojavljajo predvsem zahteve po višji mehanski trdnosti, enostavnejši izdelavi in ponovni uporabi odpadnega žganega porcelana, tj. porcelanske črepinje.

Po natančni analizi mikrostrukture obstoječega gliničnega porcelana smo sklepali, da mehansko trdnost lahko izboljšamo z izboljšanjem homogenosti mikrostrukture.

S spremenjeno pripravo smo izdelali glinični porcelan z izboljšano homogenostjo mikrostrukture. Mehanska trdnost gliničnega porcelana se je izboljšala. Izmerili smo 18% višjo upogibno trdnost kot pri referenčnem gliničnem porcelanu.

V proizvodnji porcelanskih izdelkov nastaja odpadek, ki izvira iz tehnološke obdelave. Odpadni žgani porcelan – porcelanska črepinja ima enako sestavo kot osnovna masa in je kot tak primeren za ponovno uporabo. Del surovin smo nadomestili s porcelansko črepinjo in izdelali glinični porcelan z ohranjenimi mehanskimi lastnostmi - izmerili smo enake upogibne trdnosti kot pri izboljšanem gliničnem porcelanu.



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Raziskave uporabnosti porcelanske črepinje pri pripravi gliničnega porcelana C-120



Helena Razpotnik, dipl. inž. kem.tehn.

Študijski program: Ekotehnologija
Mednarodna podiplomska šola Jožefa Stefana

MENTOR: prof. dr. Marija Kosec

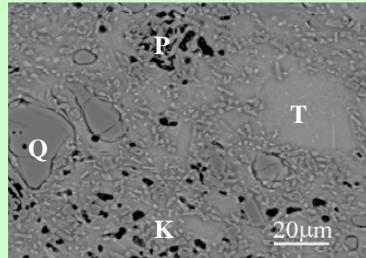
SOMENTORJA: Ivan Lavrač, ETI d.d. Izlake in dr. Janez Holc, IJS



Opis problema in obstoječega stanja:

Pri gliničnih porcelanih, ki se uporablajo za izdelavo elektrotehničnih izdelkov, se pojavljajo zahteve po:

- višji mehanski trdnosti in
- ponovni uporabi odpadnega žganega porcelana, imenovanega porcelanska črepinja.

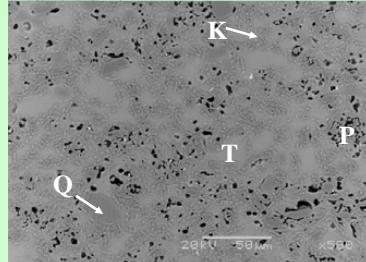


Mikrostruktura obstoječega gliničnega porcelana:
Q – kremen, T – talina, K – korund, P – pora

Upogibna trdnost:
112 MPa

Mehanske lastnosti smo izboljšali tako, da smo povečali homogenost mikrostrukture z:

- zamenjavo surovin
- zmanjšanjem prisotnosti velikih kremenovih zrn
- zmanjšanjem števila aglomeratov korundnih zrn
- zmanjšanjem področij talin
- zmanjšanjem prisotnosti skupkov in posameznih por

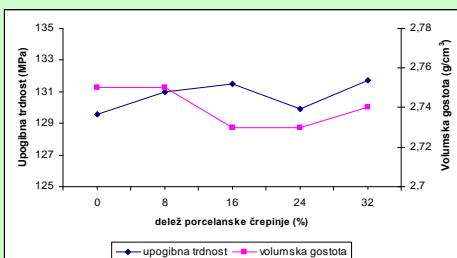


Mikrostruktura izboljšanega gliničnega porcelana:
Q – kremen, T – talina, K – korund, P – pora

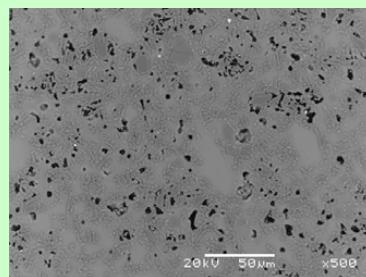
Upogibna trdnost:
133 MPa

Ponovna uporaba odpadnega žganega porcelana:

- Odpadke, ki nastanejo v proizvodnji izdelkov iz gliničnega porcelana, smo zmleli. Povprečna velikost delcev porcelanske črepinje je podobna ostalim surovinam.
- Del surovin smo nadomestili s porcelansko črepinjo (od 8 do 32 ut. %).
- Glinični porcelan z dodatkom porcelanske črepinje smo žgali pri enakih pogojih kot obstoječi porcelan.



Upogibne trdnosti in volumske gostote žganih gliničnih porcelanov v odvisnosti od količine dodatka porcelanske črepinje



Mikrostruktura izboljšanega gliničnega porcelana z dodatkov 24 ut.% porcelanske črepinje

Upogibna trdnost:
130 MPa

Zaključek:

Izboljšani glinični porcelan z dodatkom porcelanske črepinje je primeren za izdelavo osnov za visokonapetostne varovalke.



Osnove za visokonapetostne varovalke



Visokonapetostne varovalke

Poly[perfluorotitanate(IV)] Compounds. Synthesis, Characterization, Application

Igor Shlyapnikov^{1,2}, Evgeny Goreshnik¹, Zoran Mazej¹,

¹ Department of Inorganic Chemistry and Technology (K1), Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

igor.shlyapnikov@yandex.ru

Supervisor : dr. Zoran Mazej

Fluorine and its compounds are strongly associated with high energies and very important properties: chemical stability and high reactivity, resistance to high-temperatures and decomposition with release of fluorine. Thus they could be successfully applied in various branches of science, technology and everyday life. For example, highly chemically inert material Teflon and highly reactive fluorinating agent MnF_4 .

Nowadays, it became clear, that all industrial processes should be not only economically benefit, but also environmentally friendly. So, it is necessary to think about possibilities to increase yields of final products and to decrease amounts of by-products. For solving both, economic and environmental, problems applying and development of catalysts are the most promising ways.

This work is devoted to poly[perfluorotitanate(IV)] compounds, that contain poly[perfluorotitanate(IV)] anions with different structures. These substances are promising catalysts due to their selectivity to various processes that can take place in different industrial productions (pharmaceutical, waste treatment, etc).



Poly[perfluorotitanate(IV)] Compounds. Synthesis, Characterization, Application

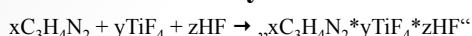
Igor Shlyapnikov^{1,2}, Evgeny Goreshnik¹, Zoran Mazej¹



¹Department of Inorganic Chemistry and Technology (K1), Institute "Jožef Stefan"

²Jožef Stefan International Postgraduate School; Ecotechnology (doctoral degree program)

Synthesis



Excess of HF

Room temperature



After isolation of product, Raman spectrum is measured

Structure determination

1. Recrystallization from HF

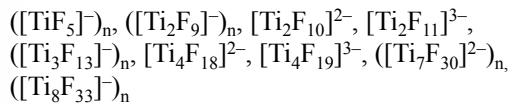


2. X-Ray diffraction on single crystal

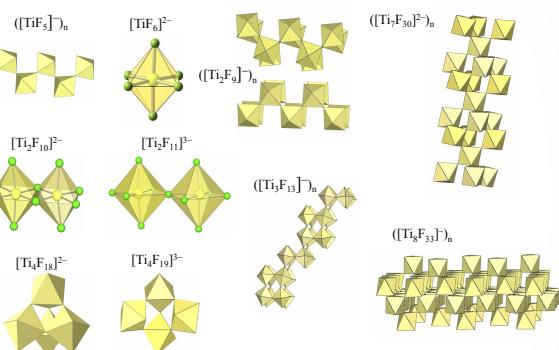


3. Raman spectra of single crystal

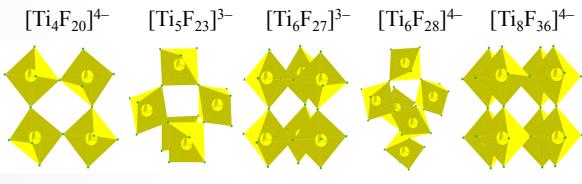
$[TiF_6]^{2-}$ anions have affinity to oligomerization and polymerization. Poly[perfluorotitanate(IV)] anions, described in literature, are listed below:



In the solid state they are found as discrete species, chains, double chains, columns or layers.



Five new poly[perfluorotitanate(IV)] anions were obtained for the first time in system imidazole – TiF_4 - aHF:



Different anions have different vibration energies, so Raman spectroscopy – good fingerprint for their detection

| Anion | Raman-shift, cm^{-1} |
|---------------------|-------------------------------|
| $[TiF_5]^{2-}$ | 607 |
| $[Ti_4F_{20}]^{4-}$ | 695 |
| $[TiF_3]^-$ | 722 |
| $[Ti_5F_{23}]^{3-}$ | 741 |
| $([Ti_2F_9]^-)_n$ | 752 |
| $[Ti_6F_{27}]^{3-}$ | 752 |
| $[Ti_8F_{36}]^{4-}$ | 803 |

Application

Efficient Lewis acid

Fluorinating agent

Stereoselective catalyst

Photocatalytic activity

Organic and polymer syntheses with high yields

Odstranjevanje ostankov zdravilnih učinkovin v pilotnih bioreaktorjih

Mojca Zupanc^{1,2}, Tina Kosjek¹, Boris Kompare³, Željko Blažeka⁴, Ester Heath^{1,2}
(MENTOR)

¹ Odsek za znanosti o okolju, Institut Jožef Stefan, Ljubljana, Slovenija

² Mednarodna podiplomska šola Jožefa Stefana, Ljubljana, Slovenija

³Fakulteta za gradbeništvo in geodezijo, Univerza v Ljubljani, Ljubljana, Slovenija

⁴Institut za ekološki inženiring d.o.o., Maribor, Slovenija

mojca.zupanc@ijs.si

V Skupini za organsko analizo Odseka za znanosti o okolju se ukvarjamo s preučevanjem kroženja organskih onesnažil v okoljskih vzorcih. V zadnjem času namenjamo večjo pozornost ostankom zdravilnih učinkovin, kot so nesteroidni antirevmatiki (NSAID), estrogeni, antidepresivi, pomirjevala in citostatiki. Naše raziskovanje se običajno prične s preučevanjem odstranitve zdravilnih učinkovin v pilotnih bioreaktorjih, ki smo jih pognali pred petimi leti z aktivnim blatom iz Centralne čistilne naprave Domžale - Kamnik. Odstranitev zdravilnih učinkovin določamo z razliko njihove vsebnosti na vtoku in izzaku iz bioreaktorjev. V naše raziskave vključujemo vedno nove zdravilne učinkovine, ki zahtevajo vpeljavo in optimizacijo novih analiznih postopkov za njihovo določitev. Poleg izhodnih zdravilnih učinkovin sledimo tudi nastanku stabilnih razgradnih produktov. Cilj naših raziskav je mineralizacija, t.j. popolna odstranitev ostankov zdravilnih učinkovin, kar vključuje tako izhodne učinkovine kot njihove razgradne produkte. Za dosego tega cilja vzporedno z biološko razgradnjo preučujemo tudi novejše tehnologije čiščenja odpadnih vod, kot so npr. ozonacija, UV razgradnja ter kavitacija. Vzporedno s kemijsko analizo v naši skupini izvajamo tudi strupenostne teste (ekotoksičnost), kjer določamo strupenost posameznih zdravilnih učinkovin ter njihovih mešanic (izhodne zdravilne učinkovine, razgradni produkti, vtoki/izzaki iz bioloških reaktorjev). Celokupno uspešnost delovanja bioreaktorjev tako ocenimo na osnovi odstotka odstranitve izbranih učinkovin ter rezultatov strupenostnih testov.



Odstranjevanje ostankov zdravilnih učinkovin v pilotnih bioreaktorjih

Mojca Zupanc^{1,2}, Tina Kosjek², Boris Kompare³, Željko Blažeka⁴, Ester Heath^{1,2}

¹Odsek za okolje, Institut Jožef Stefan;

²Mednarodna podiplomska šola Jožefa Stefana

³ Fakulteta za gradbeništvo in geodezijo

⁴IEI d.o.o.

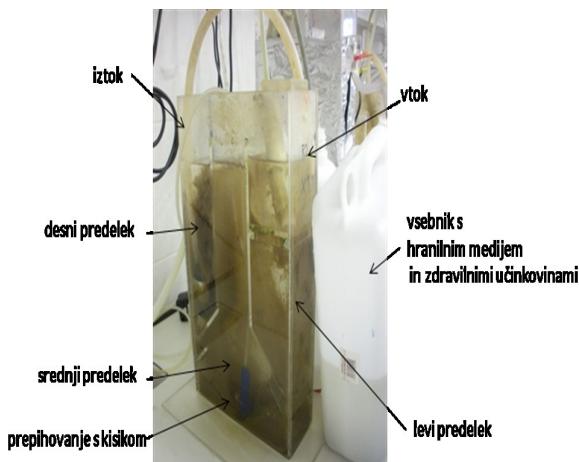


UVOD

Ostanki zdravilnih učinkovin so v okolju prisotni že od pričetka njihove uporabe, vendar se njihove potencialne nevarnosti zavedamo šele v zadnjem desetletju. Zdravilne učinkovine pridejo v okolje s humano in veterinarsko uporabo. Nizke koncentracije, v katerih se nahajajo v okolju (od ng L^{-1} do $\mu\text{g L}^{-1}$), lahko predstavljajo nevarnost za različne ekosisteme, predvsem pri kronični izpostavljenosti. V naši raziskavi smo preučevali odstranitev šestih zdravilnih učinkovin (ibuprofen, ketoprofen, naproksen, karbamazepin, klofibrinska kislina in diklofenak) z aktivnim blatom v pilotnih bioreaktorjih. Dokazali smo, da je odstranitev ibuprofena, ketoprofena in naproksena zadovoljiva (do 85%), medtem ko je razgradnja diklofenaka, karbamazepina in klofibrinske kisline nižja in nestabilna.

Bioreaktorji in kemijska analiza

Pilotni bioreaktorji z aktivnim blatom

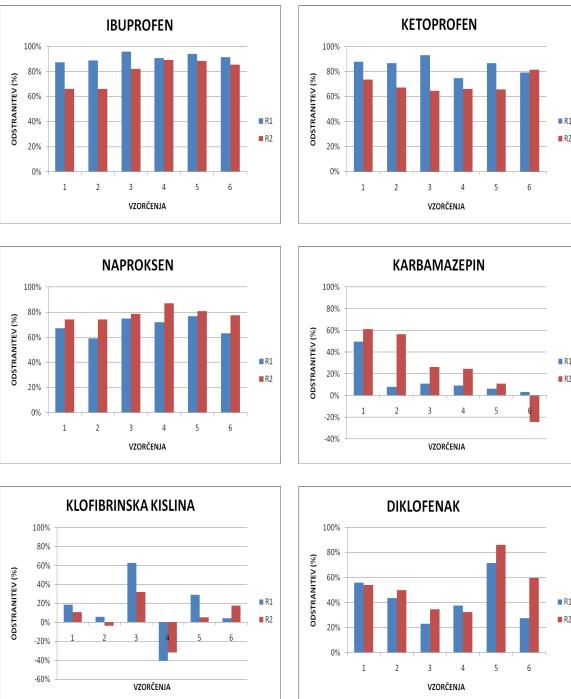


Kemijska analiza:

vzorec → filtriranje → ekstrakcija (SPE)
GC/MS ← derivatizacija ← elucija

Rezultati

Odstranitev zdravilnih učinkovin v bioreaktorjih



ZAKLJUČEK

Za zvišanje odstotka odstranitve izbranih spojin bomo biološke pilotne reaktorje sklopili z dodatnimi postopki čiščenja (UV, kavitacija, ozonacija in adsorpcija na aktivno oglje).

Informacijske in komunikacijske tehnologije (Information and Communication Technologies)

Access Control in BitTorrent P2P Networks Using the Enhanced Closed Swarms Protocol

Vladimir Jovanović^{1,2}, Dušan Gabrijelčič¹, Tomaž Klobučar¹

¹ Laboratory for Open Systems and Networks, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

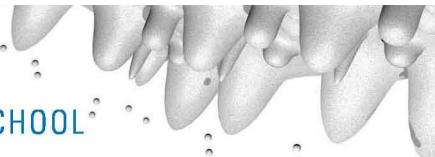
vladimir@e5.ijs.si

The vision for the future where people will consume high quality and large size media content (such as enriched 3D media content and virtual realities) and will produce most of the content, demands appropriate content delivery systems. These systems are predicted to be personalized, low-cost, user-centric and participatory, with social and collaborative connotation, suitable for large and small size content producers. Since peer-to-peer (P2P) architectures, especially ones based on BitTorrent protocol, have most of those properties, they are considered a good basis for provision of such content delivery systems. Indeed, BitTorrent P2P networks have already proved to be scalable, robust and efficient in delivery of audio and video data, and suitable for live streaming and social interaction between its users.

However, future P2P content delivery systems also need to be secure and trusted in order to be widely accepted and used. Access control is considered basic and standard security service, especially by content providers. In this paper we present a flexible access control mechanism that is able to fulfill a number of content providers' requirements, such as fine grained load balancing and optimization of the delivery process, restriction of the content delivery based on location, provision of different content quality and different business models.

Same as the BitTorrent P2P networks, the described mechanism is easy to deploy and do not require great infrastructure investments for it to function. The content provider will only need an additional software component that (in optional collaboration with a payment system) issues authorization credentials to its users. Therefore, it is suitable for professional content providers, as well as regular users that produce content.

Together with the described access control mechanism, P2P content delivery systems based on BitTorrent protocol promise to be flexible, efficient and secure systems, suitable for future content delivery.



Access Control in BitTorrent P2P Networks Using the Enhanced Closed Swarms Protocol

VLADIMIR JOVANOVIKJ, B. Sc.

Study programme: Information and Communication Technologies,
Jožef Stefan International Postgraduate School
SUPERVISOR: doc. dr. TOMAŽ KLOBUČAR
Jožef Stefan Institute, Jamova cesta 39, 1000 Ljubljana, Slovenia



- Enriched 3D media
- Virtual reality
- In great part created by regular users

FUTURE
CONTENT

FUTURE
CONTENT
DELIVERY
SYSTEMS

- Efficient, personalized, low-cost, user-centric
- Participatory, with social and collaborative connotation
- Suitable for large and small size content producers

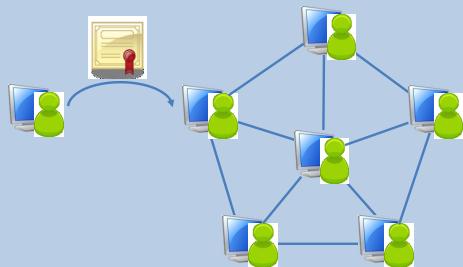
BITTORRENT P2P networks give a solid basis for provision of future content delivery systems, but need to be SECURE in order to be widely accepted and used



ACCESS CONTROL is difficult because of the intrinsic properties of the system:

- content consumers are directly involved in content delivery process
- content delivery systems tend towards full decentralization

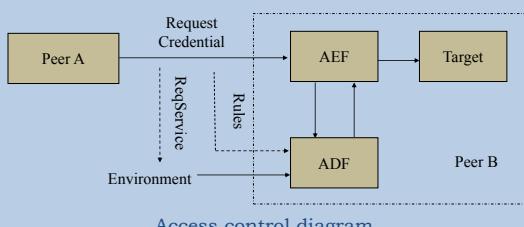
THE ENHANCED CLOSED SWARMS PROTOCOL



$SwarmID, K_S, K_A, ET, Rules_A, \{SwarmID, K_S, K_A, ET, Rules_A\}_{K_S^{-1}}$

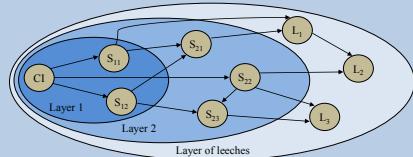
$A \rightarrow B : Version_A, SwarmID, Nonce_A$
 $A \leftarrow B : Version_B, SwarmID, Nonce_B$
 $A \rightarrow B : PoA_A, ReqService_A, \{Nonce_A, Nonce_B, PoA_A, ReqService_A\}_{K_A^{-1}}$
 $A \leftarrow B : InfoID_B, Peers_B, \{Nonce_A, Nonce_B, InfoID_B, Peers_B\}_{K_B^{-1}}$
 $A \rightarrow B : PoA_B, ReqService_B, \{Nonce_A, Nonce_B, PoA_B, ReqService_B\}_{K_B^{-1}}$
 $A \rightarrow B : InfoID_A, Peers_A, \{Nonce_A, Nonce_B, InfoID_A, Peers_A\}_{K_A^{-1}}$

Authorization credential and message exchange process



BENEFITS

- ✓ Scalability and robustness
- ✓ Efficiency in delivery of high quality content
- ✓ Applicability especially in delivery of live streaming content
- ✓ Fine grained load balancing and optimization



Hierarchical structure of a live streaming swarm

- ✓ Restriction based on location
- ✓ Delivery of content with different quality
- ✓ Support of time constraints
- ✓ Support of business models
- ✓ Suitability for
 - professional content providers
 - regular users that produce content
- ✓ Easy deployment

This work was supported by the Slovenian Research Agency (ARRS) through a grant for young researchers and by the European Commission through the P2P-Next project from the 7th Framework Programme of EU

Identifying Suspicious Behavior from Multiple Events

Boštjan Kaluža^{1,2}, Gal Kaminka³, Milind Tambe⁴

¹ Department of Intelligent Systems, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

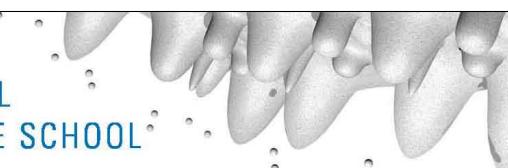
³ Bar Ilan University, Ramat Gan, Israel

⁴ Teamcore Research Group, University of Southern California, California

bostjan.kaluza@ijs.si

Identification of suspicious activities arises in many domains where an adversary has a motivating goal and exhibits behavior that deviates from behavior of normal users. The goal is to augment traditional security measures by scrutinizing behavior of all subjects in the environment. This can be applied, for example, to detect a passenger at an airport who plans to smuggle drugs while keeping contacts with authorities at minimum, to detect a pirate vessel that plans to capture a transport vessel and therefore avoids security patrols, to identify a user that misuses access to the server, to catch a reckless driver, a shoplifter, etc.

We established a formal framework and show how to optimally detect suspicious behavior from a set of observed events, where no single event is sufficient to decide whether a person behaves suspiciously or not. Unfortunately, optimal detection is not feasible in practice because we cannot estimate all required parameters. We show two approximate methods (naïve and heuristic) and compare them on an airport domain. The heuristic approach achieves high performance, discovering almost all suspicious passengers with low false-alarm ratio.



Identifying Suspicious Behavior from Multiple Events



BOŠTJAN KALUŽA

Department of Intelligent Systems, Jožef Stefan Institute,
Jamova cesta 39, 1000 Ljubljana
Jožef Stefan International Postgraduate School, study
program New Media and E-Science

Advisors:

Prof. Milind Tambe, Teamcore Research Group, University of
Southern California, Los Angeles, California

Prof. Gal Kaminka, Bar Ilan University, Ramat Gan, Israel

Problem Statement

Goal:

Detect suspicious behavior from a collection of individual trigger events

- No single event is enough to decide (no incidents)
- Combination of events enables reasoning

Main challenges:

- Trigger events are noisy
- Trigger events involve interactions of multiple agents making recognition under noise difficult
- Our belief that person is acting suspiciously increases with the number of suspicious events non-linearly
- Subject's behavior in the past affects current evaluation

Where Can It Be Applied?

- Adversary has a motivating goal
- His/her behavior deviates from behavior of regular subjects

Detect Server Attack
Observe users' actions to identify individuals who misuse server access.



Find Pirate Vessel
Observe how vessels interact with security patrols to identify pirates.

Catch Dangerous Drivers
Observe driving maneuvers to identify dangerous/reckless drivers.



Catch Shoplifter
Automatize video surveillance in shopping center to detect shoplifting from a series of events.

Example: Detecting Suspicious Passenger at the Airport

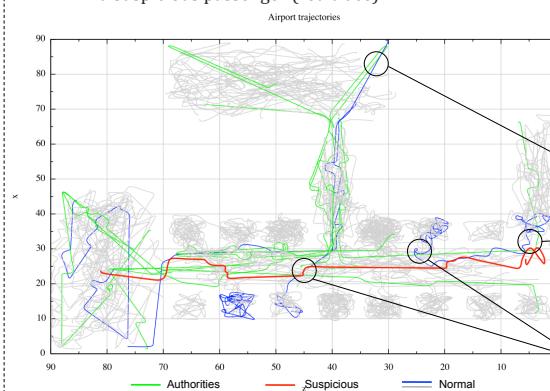
Goal: detect passengers that try to achieve a secured point

- Go from point A to B (e.g., to smuggle drugs, plant a bomb, gain access...)
- Keep contacts with authorities at minimum
- Scenario defined by airport security experts



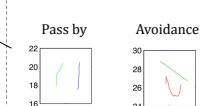
Input: 2D traces of all passengers

- Produced by multiagent simulator ESCAPES
- Find suspicious passenger (red trace)



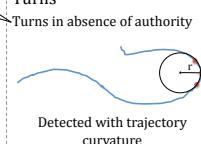
Trigger events

Interactions with authorities



Detected with Coupled Hidden Markov Models

Turns in absence of authority



Detected with trajectory curvature

Detectors

Bayes-Optimal Detector

- Optimal detector!
- We have no direct knowledge to estimate parameters
- We need approximate approaches

Naïve-Bayes Detector

- Assumes event independence
- Assumes that events are generated by stationary processes
- Model is over-simplified

Scoring Function

- Class of *well-behaved* functions
- Well-behaved heuristic function
 - Considers behavior in the past
 - Exponential increase in suspicion
 - Exponential time decay

ACKNOWLEDGMENTS: The authors would like to thank Zhengyu Yin for valuable discussion and suggestions, and Jason Tsai and Matthew Brown for their help with implementation challenges in the ESCAPES simulator. This research was done during Boštjan Kaluža's extended visit to Teamcore Research Group at University of Southern California. His work was supported partly by the Slovene Human Resources Development and Scholarship Fund and partly by the Slovenian Research Agency.

Prepoznavanje ljudi na podlagi njihove hoje

Simon Kozina^{1,2}, Matjaž Gams^{1,2}

¹ Odsek za inteligentne sisteme, Institut Jožef Stefan, Ljubljana, Slovenija

² Mednarodna podiplomska šola Jožefa Stefana, Ljubljana, Slovenija

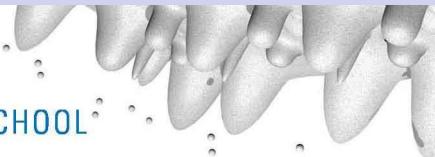
simon.kozina@ijs.si

Osnovni cilji Odseka za intelligentne sisteme so raziskave računalniških osnov intelligence in razvoj naprednih aplikacij s področja intelligentnih informacijskih storitev, analize podatkov, intelligentnega preiskovanja spletja, podpore odločanja, intelligentnih agentov, medicine, ekologije, jezikovnih tehnologij, intelligentne proizvodnje in ekonomije. Podobno kot ta članek, so tudi druge raziskave usmerjene predvsem na delo, ki vključuje podatke iz meritcev pospeška, giroskopov in meritcev magnetnega polja. Trenutno zastavljeni cilji so uspešno prepoznavanje aktivnosti s čim manjšim številom senzorjev in računanje porabe energije pri človeku, kar bi kasneje združili v sistem za učinkovito upravljanje zdravja posameznika skozi celoten cikel oskrbe. Trenutno zaključujemo tudi projekt, kjer smo s sistemom, ki določa pozicijo človeka v prostoru, uspešno prepoznali padce, poleg tega pa je sistem prepoznaval tudi ostale aktivnosti, ki jih človek opravlja skozi dan.



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INTERNATIONAL
POSTGRADUATE SCHOOL



PREPOZNAVANJE LJUDI NA PODLAGI NJIHOVE HOJE

SIMON KOZINA, univ. dipl. inž. rač. in mat.

Študijski program: Informacijske in komunikacijske tehnologije
Mednarodna podiplomska šola Jožefa Stefana

MENTOR: prof. dr. Matjaž GAMS
SOMENTOR: dr. Mitja LUŠTREK

Inštitut Jožef Stefan, Jamova cesta 39, 1000 Ljubljana



PREBIVALSTVO SE STARA

Do leta 2060 bo več kot 50% ljudi starejših od 65 let.

SISTEM ZA PODPORO STAREJŠIH LJUDI

Potrebujemo sistem, ki bi starejšim ljudem omogočal čim daljše samostojno življenje.

VEČ KOT EN SAM UPORABNIK

Če je več uporabnikov, lahko pomagamo le, če vemo, kdo sistem v danem trenutku uporablja.

RAZPOZNAVANJE LJUDI NA PODLAGI HOJE

Nadzor se opravlja s pospeškomerji, s katerimi lahko prepoznavamo hojo določenega človeka.

TOK PODATKOV

Iz pospeškomerov dobimo tok podatkov, katerega moramo spremeniti v obliko primerno za strojno učenje.

ČASOVNI INTERVALI

Tok podatkov razdelimo na več časovnih intervalov fiksne dolžine.

ATRIBUTI

Če želimo časovne intervale uporabiti za strojno učenje, jih moramo opisati z določenimi atributi.



$$\delta^2 = \frac{\sum_{i=1}^N (a_i - \bar{a})^2}{N}$$

$$\omega = \arctan\left(\frac{a_{max} - a_{min}}{t_{a_{max}} - t_{a_{min}}}\right)$$

$$\varphi = \arccos\left(\frac{a_z}{\sqrt{a_x^2 + a_y^2 + a_z^2}}\right)$$

88.6% je znašala točnost določanja posamezne osebe.

IPSSC: Self-reparable systems on FPGA

Uroš Legat^{1,2}, Franc Novak^{1,2}

¹ Computer systems department, Jožef Stefan Institute, Ljubljana, Slovenia

² Jozef Stefan International Postgraduate School, Ljubljana, Slovenia

uros.legat@ijs.si

Field Programmable Gate Arrays (FPGA) are programmable logic circuits that are increasingly used in industry, research, transport, banking systems, servers, and numerous other applications. FPGAs are also used in mission critical systems like aircraft and space exploration missions. Advantages of FPGAs to standard ASIC chips are fast prototyping, faster time to market, reconfigurability, lower costs in lower part numbers.

The functionality of the FPGA circuit is determined by configuration memory. FPGA can be reprogrammed any number of times with different systems. FPGAs can be programmed with a simple logic function or a complete System on Chip (SOC) with microprocessors and other peripherals. Configuration memory of the FPGA comprises Static Random Access Memory (SRAM) cells which lose their content when they are powered off. When the device is powered on, it has to be reconfigured. Stand-alone applications have to have their configuration stored in external non-volatile memory.

The configuration memory of FPGA is vulnerable to high energy radiation which can cause a configuration bit inside the memory to flip and consequently alter the functionality of the circuit. These so called soft errors are very common in space where the radiation levels are high. But it has also been demonstrated that considerable risk of these soft errors exists in avionics and terrestrial applications. Therefore to protect the applications that require high level of reliability error recovery techniques have to be applied.

To protect the reliable and mission critical applications on FPGA, we propose three different architectures of self-reparable systems. The systems are all based on a small error recovery circuit inside the FPGA. According to the desired level of protection, the system designer can decide between these three architectures with different overheads.



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Self reparable systems on FPGA

Uroš Legat, univ. dipl. inž. el.

Program: New media and e-science,

Jožef Stefan International Postgraduate School

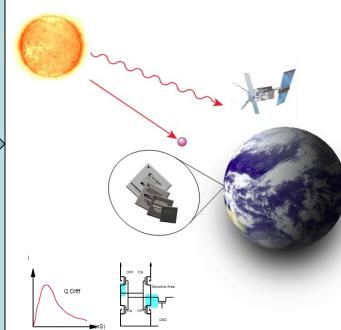
Advisor: prof. dr. Franc Novak

Inštitut Jožef Stefan, Jamova cesta 39, 1000 Ljubljana



Field Programmable Gate Arrays (FPGA)

- programmable logic circuits
- configuration memory determines the function of the FPGA
- FPGA can be programmed only with a simple logic function or a complete System on Chip (SOC) with microprocessors and other peripherals
- FPGAs are increasingly being used in industry, research, transport, and numerous other applications
- Advantages of FPGAs are fast prototyping, faster time to market, reconfigurability offers subsequent hardware updates and repairs
- FPGAs are also being used in mission critical systems like aircrafts and space exploration missions



Faults in FPGAs

- Radiation effects known as single-event upsets (SEU) have been recognized as a key reliability concern for many current and future silicon based integrated circuit technologies especially SRAM Field Programmable Gate Arrays (FPGAs).
- High energy particle strikes a critical node creating a potential that can cause a bit flip in the FPGA configuration memory

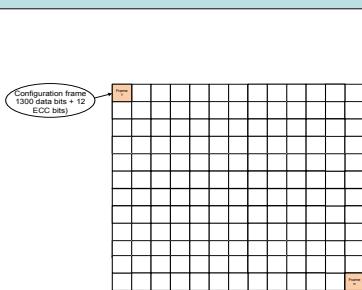


Figure 1: The FPGA configuration structure

Configuration structure of the FPGA

- The FPGA configuration memory determines the functionality of the FPGA and is organized in a network of configuration frames that are laid out on a device according to their frame address. The structure of the FPGA configuration is depicted in Fig. 1.
- A configuration frame is the smallest reconfigurable part of FPGA. The size of a frame in Virtex 4, Virtex 5 FPGA is 1312 bits. The frame has 1300 data bits and 12 Error Correcting Code (ECC) bits. These 12 ECC bits are pre calculated and can be used to check the integrity of the data in particular configuration frame.

Internal Error recovery mechanism

The internal recovery mechanism reads the FPGA configuration memory frame by frame and checks if the data in every frame is consistent with the ECC bits. The following options may occur:

- In case of error-free frame, the error recovery mechanism starts reading the next configuration frame.
- In case of a single error, the error recovery mechanism determines the location of the erroneous bit inside the frame data and corrects it by partially reconfiguring the frame.
- In case of a double error, the configuration cannot be corrected by the internal recovery mechanism. The double error is reported. Further recovery procedure in this case will be explained in the next section.

Self-reparable system 1

The most basic self-reparable system is shown in Fig 2. It contains only the internal error recovery mechanism which corrects faults in the configuration memory in concurrence with the target application. This self-reparable system fails if fault occurs in a critical bit inside the error recovery mechanism.

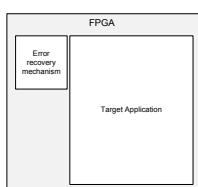


Figure 2: Self-reparable system with internal error recovery mechanism

Self-reparable system 2

Fig. 3 shows the principle of the second more advanced self-reparable system. This system has an external watchdog timer to monitor the internal error recovery mechanism. When the external watchdog timer detects the wrong operation of the internal error recovery mechanism it recovers the mechanism from external memory. This system recovers itself in a majority of cases. However, in some circumstances the external watchdog timer cannot detect the failure of the internal error recovery mechanism. In this case the self-reparable system fails.

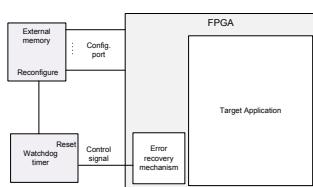


Figure 3: Self-reparable system with an external watchdog timer

Self-reparable system 3

The third proposed self-reparable system is depicted in Fig. 4. This system comprises of an internal error recovery mechanism which is implemented in Triple Modular Redundancy technique. This technique triplicates the original circuit. The outputs of the three modules of the circuit are connected to the majority voter which excludes the outputs of the faulty module. This self-reparable system fails if a fault occurs in the small voter circuit or in two modules at the same time. This self-reparable system has a very small possibility of failure but takes three times more FPGA resources.

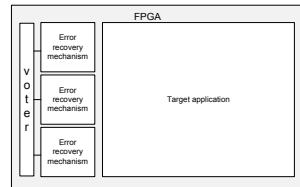


Figure 4: Self-reparable system with internal error recovery mechanism in TMR

Copula regression based ranking of non-linear decision options

Biljana Mileva-Boshkoska^{1,2}

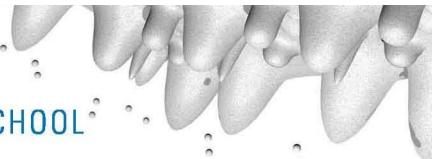
Marko Bohanec^{1,2}

¹ Department of Knowledge Technologies, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

biljana.mileva@ijs.si, marko.bohanec@ijs.si

In everyday life people are faced with a variety of decision problems in selection of the best action from a set of possible alternatives (choices) based on a set of attributes (objectives or criteria). Humans have the upper limit capacity to group the large number of alternatives into five to nine classes. In order to overcome these shortcomings and additionally to perform a consistent overall alternative evaluation and ranking within a single class, we focus on developing of multi-criteria decision modelling methods. The decision modelling methods can be divided into two groups: quantitative and qualitative ones. Quantitative decision making methods are used when the objective is clearly defined. In these methods, it is possible to quantitatively measure the values of alternatives and their attributes. On the other hand, the qualitative decision making methods are applied in decision problems that are represented descriptively. Usually for such problems an explicit quantitative model does not exist. Qualitative problems are described based on the background knowledge of the experts. Consequently, it is difficult to define strict mathematical models for these problems. This results from insufficient data, imperfect knowledge about the problem or the numerous and loosely defined alternatives. Hence, we seek for decision methods that will be able to handle qualitative alternatives with various attribute inconsistencies, such as missing data, different data distributions, data sets, and data intervals.



COPULA REGRESSION BASED RANKING OF NON-LINEAR DECISION OPTIONS

BILJANA MILEVA-BOSHKOSKA, MSc in elec. engineering

Study program: Ecotechnology,
International Postgraduate School at Jožef Stefan Institute
MENTOR: prof. dr. MARKO BOHANEK
Inštitut Jožef Stefan, Jamova cesta 39, 1000 Ljubljana

PROBLEM DESCRIPTION

If you have many varieties of the same product, how to rank them in order to choose the best one?



Source of photos: The Economist, 306, 2010

APPLICATION

Stage 1

Qualitative options in tabular format

| No. | Attribute 1 | Attribute 2 | Class | No. | Att. 1 | Att. 2 | Class |
|-----|-------------|-------------|-----------|-----|--------|--------|-------|
| 1 | excellent | poor | poor | 1 | 4 | 1 | 1 |
| 2 | good | very good | poor | 2 | 2 | 3 | 1 |
| 3 | very good | excellent | poor | 3 | 3 | 4 | 1 |
| 4 | excellent | good | good | 4 | 4 | 2 | 2 |
| 5 | poor | excellent | good | 5 | 1 | 4 | 2 |
| 6 | good | good | very good | 6 | 2 | 2 | 3 |
| 7 | poor | excellent | very good | 7 | 1 | 4 | 3 |
| 8 | poor | poor | excellent | 8 | 1 | 1 | 4 |
| 9 | very good | poor | excellent | 9 | 3 | 1 | 4 |
| 10 | good | good | excellent | 10 | 2 | 2 | 4 |
| 11 | good | very good | excellent | 11 | 2 | 3 | 4 |
| 12 | very good | very good | excellent | 12 | 3 | 3 | 4 |

poor < good < very good < excellent 1 < 2 < 3 < 4

Stage 3

Final ranking of the options

| No. | Att. 1 | Att. 2 | Class | Clayton | Clayton normalized | QQ |
|-----|--------|--------|-------|---------|--------------------|------|
| 1 | 4 | 1 | 1 | 2.05 | 0.50 | 1.16 |
| 2 | 2 | 3 | 1 | 2.48 | 1.40 | 1.25 |
| 3 | 3 | 4 | 1 | 2.53 | 1.50 | 0.75 |
| 4 | 4 | 2 | 2 | 2.50 | 2.50 | 1.79 |
| 5 | 1 | 4 | 2 | 2.05 | 1.50 | 2.21 |
| 6 | 2 | 2 | 3 | 2.45 | 3.50 | 3.14 |
| 7 | 1 | 4 | 3 | 2.05 | 2.50 | 2.86 |
| 8 | 1 | 1 | 4 | 1.76 | 3.50 | 4.33 |
| 9 | 3 | 1 | 4 | 2.04 | 3.88 | 3.97 |
| 10 | 2 | 2 | 4 | 2.45 | 4.42 | 4.00 |
| 11 | 2 | 3 | 4 | 2.48 | 4.46 | 3.85 |
| 12 | 3 | 3 | 4 | 2.51 | 4.50 | 3.67 |

METHODS

1. Qualitative - Quantitative method for ranking of linear options

Stage 1: Map qualitative data to quantitative ones with a relation that preserves the preferences of the decision maker

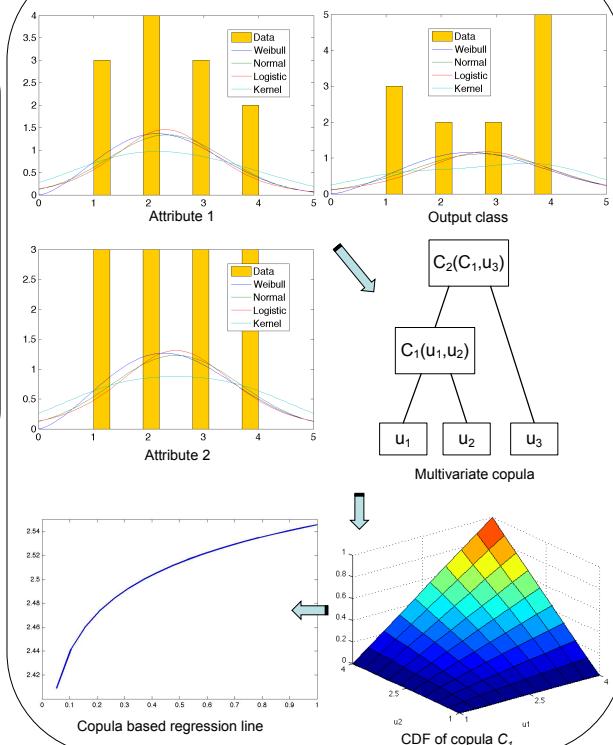
Stage 2: Use least square regression to find the function g

Stage 3: Normalize the results of g into classes $c \pm 0.5$ to preserve the class c and the rank

2. Copula regression method for ranking of non-linear options

Upgrade the second stage of Qualitative - Quantitative method: instead of least square regression, use copula regression

Stage 2



CONCLUSION

Copula based regression manages to:

- rank non-linear options unlike QQ method
- rank the same option in different classes .

Aligning business intelligence systems to end-user segments

Violeta Mirchevska^{1,2}, Igor Korelič¹

¹ Result d.o.o., Ljubljana, Slovenia

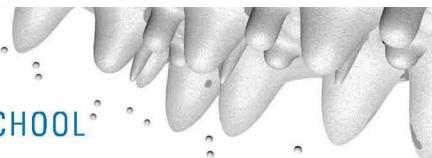
² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

violeta.mircevska@result.si

Business intelligence systems are comprehensive systems which aim to accommodate all of the information needs of an organization. As stated by Luhn (1958), one of the first authors to introduce the notion of business intelligence systems, the term *business* in business intelligence systems refers to “a collection of activities carried out for whatever purpose, be it science, technology, commerce, industry, law, government, defence, et cetera”, whereas *intelligent system* refers to the underlying “facility serving the conduct of business (in the broad sense)”. The notion of intelligence means that these systems perform advanced data processing activities in order to determine and disseminate interrelationships in business data in “such a way as to guide action towards a desired goal”.

Although business intelligence systems provide valuable insights into business data, supporting decision-making at all levels, practice shows that without proper adaptation of the information presentation to the needs and preferences of the users these systems fall short in fulfilling users’ expectations. The goal of this research is to develop a methodology that will present the right information to the right user at the right time in the business intelligence system.

The methodology for providing customized content to users is based on user segmentation, i.e. each user is assigned to a set of predefined segments based on his/her information needs and preferences. Although the information needs and preferences of the user can be obtained explicitly (e.g. by questionnaires), we aim at implicit determination of this data. As user interaction with the business intelligence system is purposeful, i.e. users perform actions in order to achieve concrete goals, we use data traces of past user interaction with the business intelligence system for determining end-users’ needs and preferences. Based on the determined end-users’ needs and preferences, user segments are determined by clustering. For each segment, we determine optimal data presentation using multi-criteria decision analysis.



ALIGNING BUSINESS INTELLIGENCE SYSTEMS TO END-USER SEGMENTS

VIOLETA MIRCHEVSKA, IGOR KORELIČ

Study programme: New Media and E-Science,

Jožef Stefan International Postgraduate School

MENTORS: prof. dr. Matjaž Gams, dr. Mitja Luštrek, Igor Korelič

RESULT Computer Systems d.o.o.

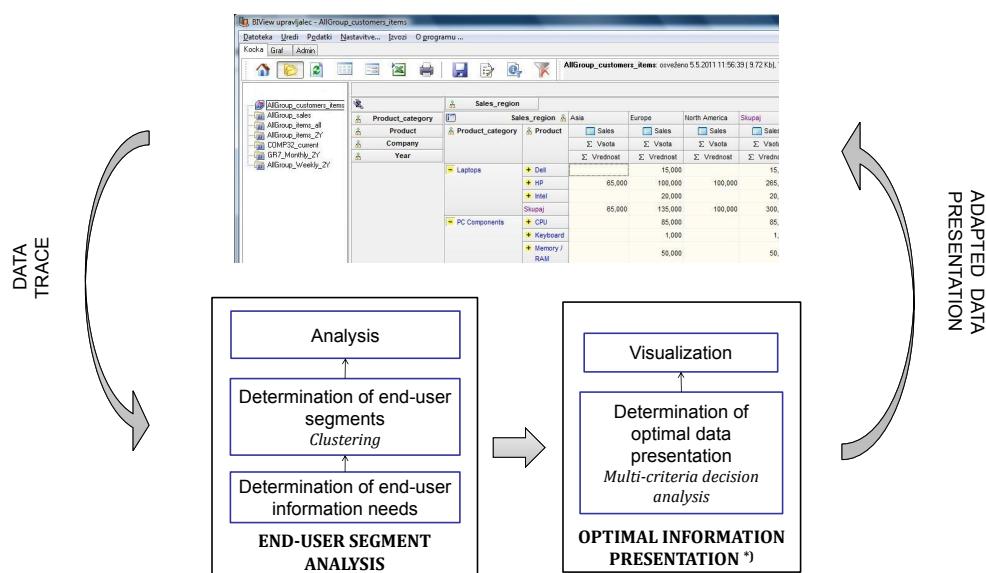
Bravničarjeva 11, 1000 Ljubljana



BUSINESS INTELLIGENCE SYSTEMS

- comprehensive systems which aim to accommodate all of the information needs of an organization
- practice shows that without proper adaptation of the presentation of information to the needs of end-users, business intelligence systems may fall short in fulfilling users' expectations

ADAPTING BUSINESS INTELLIGENCE SYSTEMS TO END-USER SEGMENTS



END-USER SEGMENT ANALYSIS

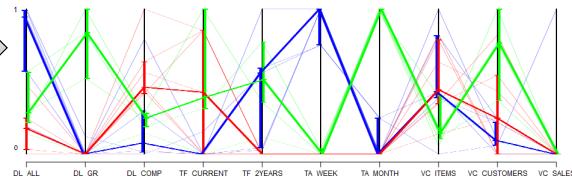
DATA TRACE

Record:
- user
- action
- accessed view
- time

DETERMINATION OF END-USER INFORMATION NEEDS

User profile:
- detail level of accessed data
- time frame
- time aggregation
- view category

DETERMINATION AND ANALYSIS OF END-USER SEGMENTS



* I. Korelič, V. Rajkovič, M. K. Borštnar. Optimizacija večrazsežnostnih podatkovnih modelov z uporabo metode večkriterijskega odločanja. *Zbornik konference Človek in organizacija*, March 2010

ACKNOWLEDGEMENTS: The research leading to this publication was partially financed by the European Union, European Social Fund.

Implementacija programa za evidentiranje in pomoč pri sestavljanju fragmentov stenskih poslikav

Miha Mlakar^{1,2}, Bogdan Filipič^{1,2}

¹ Odsek za inteligentne sisteme, Institut »Jožef Stefan«, Ljubljana, Slovenija

² Mednarodna podiplomska šola Jožefa Stefana, Ljubljana, Slovenija

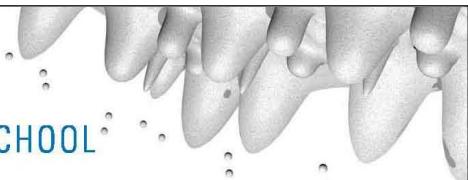
miha.mlakar@ijs.si, bogdan.filipic@ijs.si

V prispevku opisujemo program za evidentiranje in pomoč pri sestavljanju fragmentov stenskih poslikav. Program je bil razvit za naročnika Restavratorski center iz Ljubljane, za pomoč pri sestavljanju fragmentov stenskih poslikav, ki so jih našli na najdišču »Turška mačka«. Gre za bogato arheološko najdišče iz časov rimskega mesta Celeia. Fragmentov, ki so sestavljeni stensko poslikavo je več kot 9000 in so relativno dobro ohranjeni. Program omogoča detekcijo in zapis lastnosti posameznih fragmentov v za to namenjeno podatkovno bazo. Poleg tega nudi program tudi navidezno okolje za zlaganje fragmentov. To navidezno okolje nadomesti peskovnik, v katerem so do sedaj brez računalniške podpore sestavljeni fragmenti. V pomoč zlaganju je omogočeno iskanje po že evidentiranih fragmentih po različnih filtrih. Ti omogočajo iskanje po velikosti, barvi, grafičnih predlogah, značilnih črtah. Posebej za ta projekt smo razvili algoritem za odstranjevanje ozadja slike na kateri dobimo lice fragmenta in svojo diskretizacijo barvne lestvice, ki omogoča bolj oziroma manj natančno iskanje fragmentov po relativni vsebnosti določene barve. Program že aktivno uporablja za ta projekt in so po prvih odzivih z njegovim delovanjem zadovoljni.



MEDNARODNA
PODIPLOMSKA ŠOLA
JOŽEFA STEFANA

JOŽEF STEFAN
INTERNATIONAL
POSTGRADUATE SCHOOL



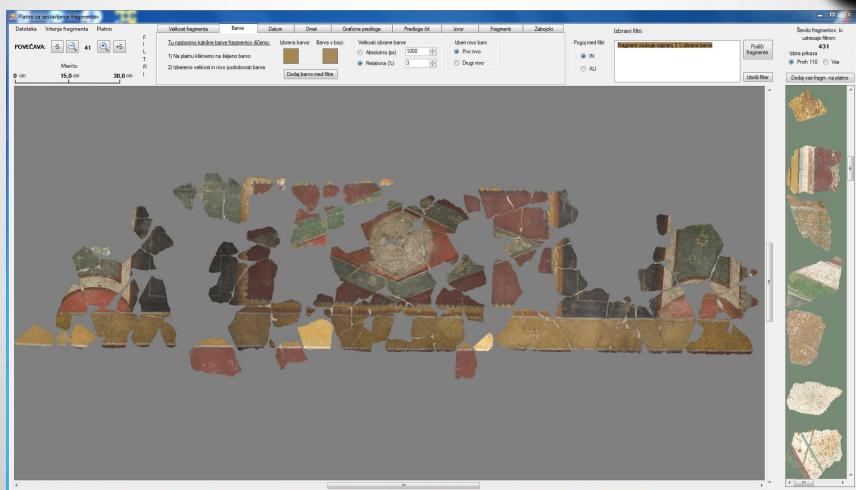
IMPLEMENTACIJA PROGRAMA ZA EVIDENTIRANJE IN POMOČ PRI SESTAVLJANJU FRAGMENTOV STENSKIH POSLIKAV

MIHA MLAKAR, UNIV. DIPLO. INŽ. RAČ. IN INF.
ŠTUDIJSKI PROGRAM: INFORMACIJSKE IN KOMUNIKACIJSKE TEHNOLOGIJE,
MEDNARODNA PODIPLOMSKA ŠOLA JOŽEFA STEFANA
MENTOR: PROF. DR. BOGDAN FILIPIČ
INSTITUT JOŽEF STEFAN, JAMOVA CESTA 39, 1000 LJUBLJANA

Program je bil razvit za
naročnika Restavratorski
center v Ljubljani, za
projekt rekonstrukcije
stenske poslikave iz
fragmentov arheološkega
nadišča "Turška mačka".

Program omogoča pomoč pri
sestavljanju predhodno
evidentiranih fragmentov
stenskih poslikav. V ta
namen omogoča iskanje
fragmentov po različnih
kriterijih kot so velikost,
identifikacijska številka,
oznaka nahajališča
fragmenta v
skladišču,
grafična
predloga itd.

Razvili smo algoritem
za diskretizacijo barvne
lestvice za iskanje po
določeni barvi.
Diskretizirali smo
lestvico HSB (hue,
saturation, brightness
oz. barvi odtenek,
nasičenost, svetlosť) in
omogočili dve različni
natančnosti iskanja.



Razvili smo algoritem za
odstranjevanje ozadja iz
slik fragmentov.
Obstoječi algoritmi
temeljijo na postopku
detektiranja robov, kar pa
za naš problem ni
ustrezno, saj se na ozadju
pojavljajo manjše barvne
napake.

Novo razviti algoritem pri
svoji detekciji uporablja več
zaporednih točk (pisklov)
na sliki in nato pregleda
povprečno barvno vrednost
in odstopanja od črne barve.
S tem odstranimo tudi
manjše barvne napake na
ozadju.

Vse fragmente smo
evidentirali. Za vsakega
smo v podatkovno bazo
shranili sliko lica
fragmenta, velikost
fragmenta, njegovo
identifikacijsko številko,
barve lica fragmenta.

Več kot 9000
različnih
fragmentov.

Connecting Contiki enabled Versatile Sensor Nodes via ISM band radio

Zoltan Padrah, Carolina Fortuna

Supervisor: doc. dr. Mihael Mohorčič

Department of Communication Systems, Jožef Stefan Institute, Ljubljana, Slovenia

Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

zoltan.padrah@gmail.com

Wireless sensor nodes are a type of hardware, typically incorporating three functions:

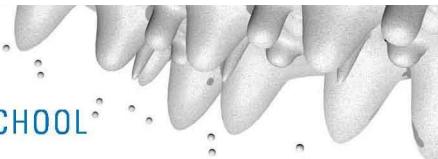
- measurement of physical quantities, by employing sensors
- performing simple processing
- communication with other sensor nodes, by using wireless technologies

Such nodes are typically deployed as a network, in order to gather measurement data from a given area.

The Versatile Sensor Node, developed by the collaboration of Jozef Stefan Institute and Isotel d.o.o., is a highly reusable sensor node. Its applications include:

- environmental monitoring and lightning control
- temperature monitoring in stables
- remote observation of sport-fishing conditions
- beehive local climate monitoring
- multispectral imaging and data harvesting over Unmanned Aerial Vehicle (UAV)

Currently we are preparing to use Versatile Sensor Nodes for monitoring the radio spectrum usage in an area. The gathered data could be used in research helping the creation of more efficient radio communication systems. For more information, visit SensorLab's web page: sensorlab.ijs.si.



CONNECTING CONTIKI ENABLED VERSATILE SENSOR NODES VIA ISM BAND RADIO

ZOLTAN PADRAH, CAROLINA FORTUNA,
Supervisor: doc. dr. MIHAEL MOHORČIČ

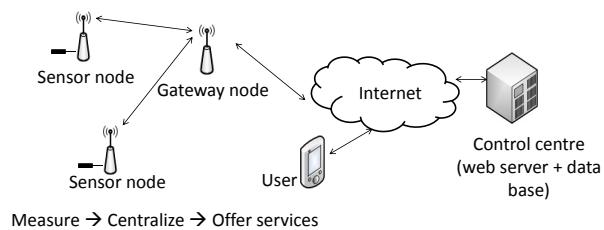
Jožef Stefan International Postgraduate School

Study program: Information and Communication Technologies

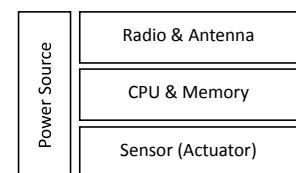
²Department of Communication Systems, Jožef Stefan Institute, Jamova cesta 39, 1000 Ljubljana



Wireless Sensor Networks (WSN)



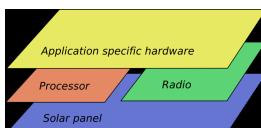
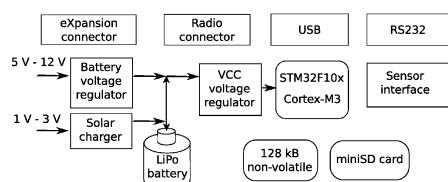
Wireless Sensor Node



WSN Node = Sensor + Microcontroller + RF + Power Source

Versatile Sensor Node

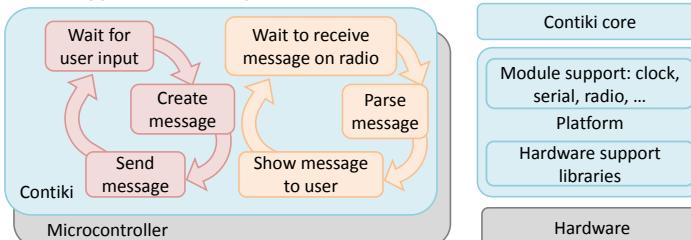
- Modular platform for WSN (VSN=VSC+VSR+VSE+VSP)
 - High processing power and low energy consumption
 - Sensor node & gateway (multi-tier / IP) capability
 - Battery, solar or external power supply
 - Re-configurable radio



- ST ARM Cortex-M3
- JTAG, USB, USART PC interface
- I2C, SPI, PWM, AD, DA, USART sensor and actuator interfaces
 - Code library: C/C++ (GCC)
- 300-900 MHz, 2.4 GHz radio interface (all ISM bands)
 - TI CC1101
- Software tools: Open Source
 - Eclipse IDE
 - Tool-chain: Sourcery G++ Lite
 - Cygwin, Linux environment for Windows
 - JTAG server: OpenOCD
 - JTAG hardware interface: Olimex ARM-USB-OCD

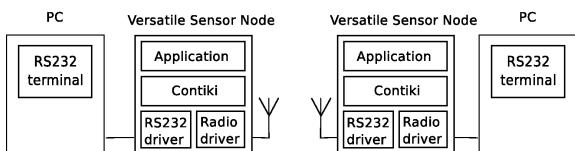
Software: based on Contiki Operating System

- Event-based
- Fast application development



Demo

Communication between users



Acknowledgements

The authors would like to thank SensorLab for its support.
sensorlab.ijs.si

Sprotno izbiranje podatkov

Dejan Petelin^{1,2}, Juš Kocijan^{1,3} (mentor)

¹ Odsek za sisteme in vodenje, Inštitut Jožef Stefan, Ljubljana, Slovenija

² Mednarodna podiplomska šola Jožefa Stefana, Ljubljana, Slovenija

³ Univerza v Novi Gorici, Nova Gorica, Slovenija

dejan.petelin@ijs.si

S hitrim razvojem tehnologije se povečuje tudi količina podatkov, ki jih želimo obdelati. Med temi podatki je lahko veliko podvojenih oziroma odvečnih podatkov. To pomeni, da lahko sistem opišemo tudi z manjšim številom podatkov kot jih imamo na voljo. Pri tem pa je zelo pomembna izbira pravih podatkov oziroma podatkov, ki nosijo največ informacije. V veliko primerih se proces oziroma njegove zakonitosti s časom tudi spreminja, zato je izbiro podatkov oziroma model na podlagi uporabljenih podatkov potrebno sproti prilagajati.

Za sprotno izbiranje podatkov predlagamo modele na podlagi Gaussovih procesov ali krajše GP modele, saj temeljijo na podatkih in so enostavni za uporabo. Njihova glavna prednost je dostopen podatek o zaupanju v napoved, ki jo podajajo. Ta dodatni podatek je zelo uporaben pri ocenjevanju informativnosti oziroma novosti novega vhodnega podatka.

Ker GP modeli temeljijo na podatkih, je izbiranje podatkov zelo enostavno, saj izbrani podatki služijo kot učni podatki GP modela. Imenujemo jih množica izbranih podatkov ali krajše množica IP. Tako lahko informativnost izbranih podatkov ocenujemo preko kakovosti GP modela. Bolj kot je kakovosten GP model, bolj kakovostni so podatki.

Poleg izbiranja podatkov se z uporabo metode avtomatskega določanja ustreznosti in sprotno optimizacijo vrednosti hiperparametrov samodejno določa tudi pomembnost posameznih dimenzij vhodnih podatkov oziroma regresorjev. Nepomembni regresorji so tako s časom lahko tudi izključeni iz sprotnega izbiranja.



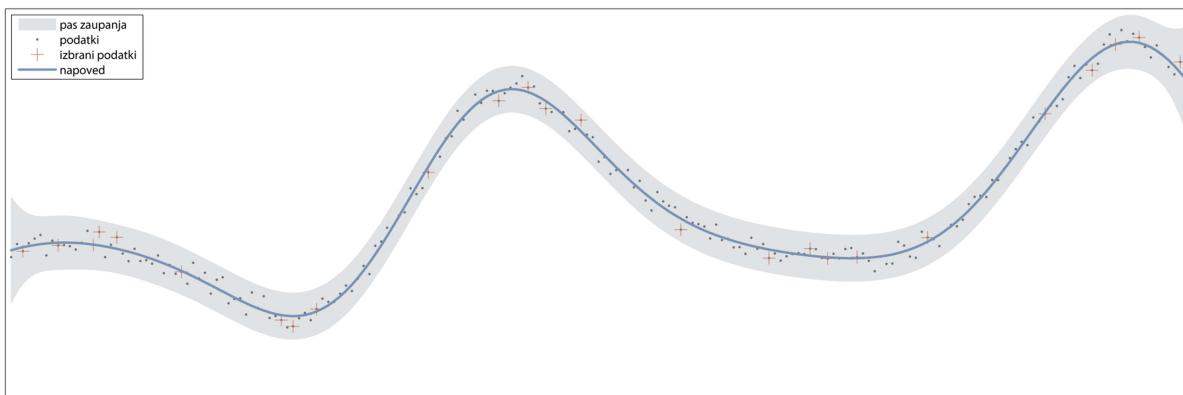
SPROTNO IZBIRANJE PODATKOV

Dejan Petelin, univ. dipl. inž. rač. in inf.

Program: Informacijske in komunikacijske tehnologije,
Mednarodna podiplomska šola Jožefa Stefana

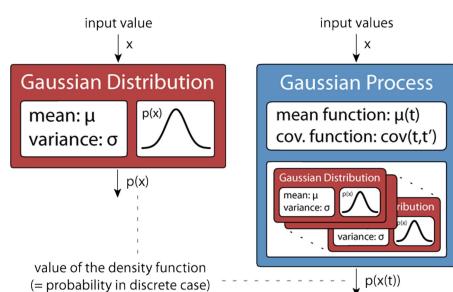
Mentor: prof. dr. Juš Kocijan

Institut "Jožef Stefan", Jamova cesta 39, 1000 Ljubljana

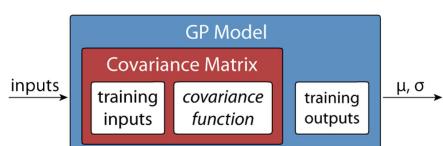


MODELI NA PODLAGI GAUSSOVIH PROCESOV

- Neparametrični modeli
- Verjetnostni modeli,
- Modeli "črne škatle" (ang. black-box models)
- Iščejo relacije med podatki
- Modeli z jedrno funkcijo



- So zelo enostavni za uporabo
 - Izberi kovariančne (jedrne) funkcije
 - Podajajo podatek o zaupanju v napoved (varianca)
 - Dobro v primeru pomanjkanja podatkov



SPROTNA IZBIRA PODATKOV

- Informativnost ocenjujemo preko kakovosti GP modela
- Bolj kakovosten GP model → bolj kakovostni podatki
- Množica izbranih (najinformativnejših) podatkov – množica IP
- Za vsak novi podatek izvedemo:

1. Za vhodni podatek na podlagi trenutnega modela napovedemo izhodno porazdelitev.
2. Če je napaka (razlika med napovedano srednjo vrednostjo in izmerjeno vrednostjo) večja od določene meje,
3. vhodni podatek dodamo v množico IP,
4. sicer preverimo še varianco.
5. Če je varianca večja od določene meje
6. vhodni podatek dodamo v množico IP, saj model ni prepričan v svojo napoved,
7. sicer ga ne dodamo v množico IP, saj model že dovolj dobro oceni izhodno vrednost

- Velikost množice IP lahko tudi omejimo. V tem primeru po preseženi velikosti izvedemo:

1. Vsem podatkom v množici IP s pomočjo metode največje podobnosti (ang. Maximum likelihood) ocenimo informativnost
2. Podatek z najnižjo oceno informativnosti izbrišemo iz množice IP

- Po vsaki novi vključitvi podatka v množico IP, se izvede še optimizacija vrednosti hiperparametrov, za čim boljšo nadaljnjo izbiro podatkov

Pristop podatkovnega rudarjenja časovnih vrst za detekcijo zdravstvenih težav pri starejših

Bogdan Pogorelc^{1,2,3}

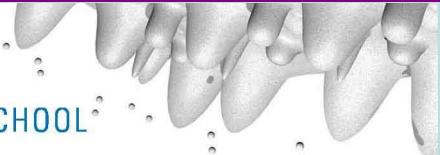
¹ Institut Jožef Stefan, Odsek za inteligentne sisteme, Ljubljana, Slovenija

² Špica International d.o.o., Ljubljana, Slovenija

³ Mednarodna podiplomska šola Jožefa Stefana, Ljubljana, Slovenija

bogdan.pogorelc@ijs.si

Po napovedih naj bi do leta 2050 v razvitih državah živelo šestkrat toliko ljudi nad 80 let kot danes. Starejši navadno živijo izolirani od potomcev, zato v primeru bolezni ali poškodbe težko dobijo pravočasno pomoč. Namen te študije je razviti tehnologije, ki bi olajšale samostojno življenje starejših. Članek predstavlja pristop k razvoju sistema za detekcijo zdravstvenih težav in padcev pri starejših z namenom podaljševanja njihovega samostojnega življenja. Če je zaznan padec ali zdravstvena težava, sistem avtomatsko obvesti medicinsko službo. Gibanje starejših je zajeto s sistemom za zajem gibanja in celoten sistem je naučen, da prepozna specifične zdravstvene težave ali padce. Pristop je splošen, ker za atribute uporablja vse izmerljive kote sklepov namesto specifičnih atributov za posamezne bolezni. Kljub temu dobro prepozna zdravstvene težave, podobno kot specifični pristopi iz literature.



Pristop podatkovnega rudarjenja časovnih vrst za detekcijo zdravstvenih težav pri starejših

BOGDAN POGORELC, univ. dipl. inž. el.

Študijski program: Informacijske in komunikacijske tehnologije,

Mednarodna podiplomska šola Jožefa Stefana

MENTOR: prof. dr. Matjaž Gams

Inštitut Jožef Stefan, Jamova cesta 39, 1000 Ljubljana



- Predlagamo pristop podatkovnega rudarjenja k intelligentnemu in vseprisotnemu sistemu nadzora zdravja.
- Cilj pristopa je prepozнатi nekaj najpogostejših in najpomembnejših bolezni starejših, ki so lahko razpozname z opazovanjem in analizo karakteristik njihovega gibanja.

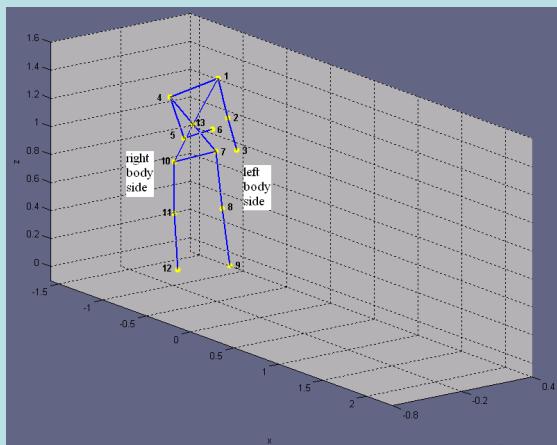
Materiali in metode

Ciljne aktivnosti in zdravstvene težave za detekcijo. Vse situacije, ki jih prepoznavamo, je predlagal sodelujoči medicinski strokovnjak na osnovi pogostosti nad 65 let starosti, medicinske pomembnosti in možnosti razpoznavanja iz gibanja. Predlagan sistem uporablja dvostopenjski sistem za razpoznavo pomembnih situacij. V prvem koraku razpoznavajo med petimi aktivnostmi: padec zaradi nesreče, padec zaradi bolezni, hoja, vstajanje/sedanje, uleganje/vstajanje. V drugem koraku razpozname hoje iz prvega koraka klasificira kot: Parkinsonovo bolezen, hemiplegijo, bolečine v hrbtni, bolečine v nogah ali normalno hojo. Oba koraka sta izvedena z metodo k-najbližjih sosedov in dinamičnim ukrivljanjem časa (dynamic time warping oz. DTW) za mero podobnosti.

Atributi za podatkovno rudarjenje:

- kot levega in desnega ramena glede na zgornji del trupa v trenutku t ,
- kot levega in desnega kolka glede na spodnji del trupa,
- kot med spodnjim in zgornjim delom trupa,
- levi in desni komolčni ter levi in desni kolenski kot.

Dinamično ukrivljvanje časa. Dinamično ukrivljvanje časa (DTW) poravnava 2 časovne vrsti na način, da minimizira neko mero. Optimalna poravnava je dobljena s preslikavo več zaporednih vrednosti ene časovne vrste v eno vrednost druge časovne vrste in tako je lahko DTW računan tudi na časovnih vrstah različnih dolžin. V nasprotju z Evklidsko razdaljo, DTW lahko najde podobnosti med vzorcema dveh časovnih vrst tudi če ta vzorca nista časovno poravnana ali pa sta vzorci različnih dolžin.



Eksperimenti in rezultati. Uporabili smo 256 meritev zdravih posameznikov in posameznikov z določenimi zdravstvenimi težavami, pri čemer je bil vsak posameznik 4-5 krat posnet z različnimi hitrostmi izvajanja aktivnosti. Klasifikacijski proces upošteva eno vhodno testno časovno vrsto, ki jo primerja z vsemi ostalimi, da najde minimalno globalno razdaljo za vsako poravnavo in sklepa, da je vhodna meritev istega razreda kot učna meritev, ki ima najmanjšo razdaljo do te vhodne meritve. Metoda "izpusti enega" (leave one out) za 5-najbližjih sosedov da klasifikacijsko točnost 97.5 % za aktivnosti/padce in 97.6 % za zdravstvena stanja.

Zaključek. Članek predstavlja splošni pristop k detekciji zdravstvenih težav in padcev za namen podaljšanja samostojnega življenja starejših. Je splošen, ker ne uporablja specifičnih atributov, ampak splošen pristop iz kombinacije DTW in k-najbližjih sosedov. Dobimo klasifikacijsko točnost 97.5 % za aktivnosti/padce in 97.6 % za zdravstvena stanja. Kljub temu, da je metoda splošna in lahko razpozna tudi nove vrste gibanj, dosega visoke klasifikacijske točnosti, podobne pristopom s specifičnimi atributi iz literature.

Zahvala. Operacije, ki so pripeljale do tega članka, je delno sofinancirala Evropska Unija, Evropski socialni sklad. Avtor članka se zahvaljuje mentorju prof dr. Matjažu Gamsu za pomoč.

Process-aware Information Resource Delivery

Tadej Štajner^{1,2}, Dunja Mladenčić^{1,2}, Marko Grobelnik¹

¹ Artificial Intelligence Laboratory, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

Supervisor: prof. dr. Dunja Mladenčić

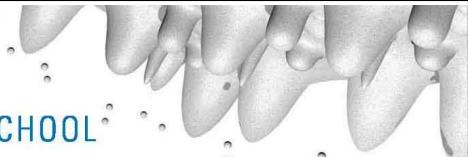
tadej.stajner@ijs.si (email of corresponding author)

The research presented in this article aims to find novel ways to apply machine learning methods to problems that knowledge workers are facing nowadays with information overload and constant context switching.

Knowledge workers can be roughly defined as professionals which use knowledge resources in their day-to-day tasks. In practice, they may be sales people pitching products, consultants preparing projects, engineers implementing the latest technology or even scientists doing their research. What they all have in common is that their efficiency is largely conditioned on how much effort does it takes to access existing knowledge resources, such as e-mail conversations, project proposals, technical documentation and so on.

The aim of this work is developing a model in the knowledge worker domain that can be conducive to applying machine learning techniques and actually design and implement the algorithms that could enable them to be more productive in their workflows by automatically learning about these workflows.

Academically, the problem is challenging because the data representation needs to be rich enough to model the interesting dependencies between events, and the algorithms fast enough to handle the rich complex graph representation in a way that can be delivered in an on-line fashion to users. There are two hard problems: just-in-time information retrieval and underneath, complex graph clustering. For end users, these approaches can make their productivity significantly higher by having them focused on the task at hand instead of being stuck looking for files in deep hierarchies of folders.



Process-aware Information Resource Delivery



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¹ Artificial Intelligence Laboratory, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School

tadej.stajner@ijs.si

Goal

Proactively assist knowledge workers with their workflows by suggesting them relevant information resources by learning their knowledge process.

Knowledge workers: people whose work consists of using knowledge resources;

Information resources: atomic elements of the work domain, like e-mail messages, visited web pages, Office documents;

Knowledge process: a model that describes the dynamics of how a knowledge worker is using his resources in a given point in his workflow;

Problem statement

Can we improve recommendation of information resources given a knowledge process model of a particular user?

Constraints:

- learning should be unsupervised, given only logs of user activity on his desktop
- recommendations need to be just-in-time with sufficient performance and relevance
- method should generalize multiple knowledge worker domains, such as sales, science, engineering or marketing;

Knowledge Process Framework

How can we efficiently and robustly model the information needs of a knowledge worker that will enable us just-in-time resource recommendation?

We tackle this with a combination of three model layers:

Event Model: how do we encode events? By themselves or together with the co-occurring events context?

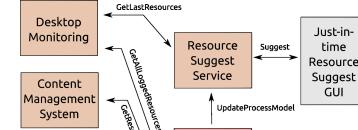
Action Model: how do we abstract events into more general atomic actions? Do we compress them into clusters? Do we treat features as independent actions?

Process Model: how do we model the conditional probability between events $n - 1$ and n , so that we will know how to predict the event $k + 1$ given event k .

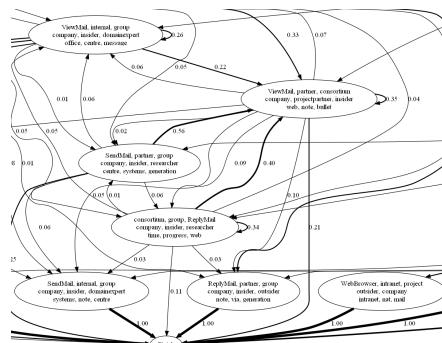
Implementation

- Desktop monitoring solution that tracks knowledge worker events, which conform to the Text-Network-Time template, so they are treated on the same basis regardless of source;

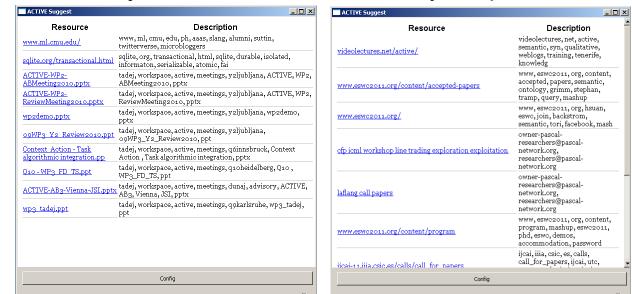
- Back-end process mining component for learning from logged data to construct information delivery models;



- Example of process model: nodes are actions (clustered events), links are learned dependencies between actions;



- Front-end just-in-time information delivery component;



Evaluation

Best model predicts correctly in more than a third cases!

| Event Model | Action Model | Process Model | Reciprocal rank | Percentage in top 20% |
|-------------|---------------|---------------|-----------------|-----------------------|
| IDF | Clustered: 10 | Independent | 0.0794 | 0.2697 |
| IDF | Clustered: 10 | Laplace | 0.1076 | 0.3485 |
| IDF | Clustered: 30 | Independent | 0.0853 | 0.3081 |
| IDF | Clustered: 30 | Laplace | 0.0793 | 0.2490 |
| SessionIDF | Clustered: 10 | Independent | 0.0756 | 0.2807 |
| SessionIDF | Clustered: 10 | Laplace | 0.0701 | 0.2384 |
| SessionIDF | Clustered: 30 | Independent | 0.0832 | 0.3013 |
| SessionIDF | Clustered: 30 | Laplace | 0.0874 | 0.3051 |

Modeliranje večagentnih sistemov

Aleš Tavčar^{1,2}, Damjan Kužnar¹, Matjaž Gams^{1,2} (mentor)

¹ Odsek za Inteligentne sisteme, Institut "Jozef Stefan", Ljubljana, Slovenija

² Mednarodna podiplomska šola Jožefa Stefana, Ljubljana, Slovenija

ales.tavcar@ijs.si, damjan.kuznar@ijs.si, matjaz.gams@ijs.si

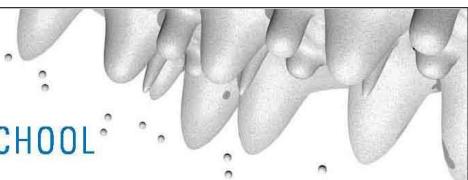
V tej raziskavi preučujemo analizo vedenja skupine agentov (tj. računalniško vodenih avatarjev) z namenom detekcije skupne strategije, ki jo izvajajo. Metoda ni uporabna le za analizo obnašanja skupin računalniško vodenih agentov, ampak tudi posameznikov in skupine ljudi, saj poskuša med delovanjem upoštevati tudi kognitivno stanje posameznikov v skupinah. Na primer, neka oseba se pod stresom v določeni situaciji odziva na popolnoma drugačen način, kot če je popolnoma sproščena.

Metoda ima širok spekter uporabe. Lahko se jo aplicira na večino problemov, ki jih lahko predstavimo z več-agentnim sistemom. Od analize obnašanja uporabnikov v računalniški mreži, navad uporabnikov določenega programskega paketa, pa vse do analize interakcij uporabnikov socialnih omrežij.

Metoda se lahko uporabi tudi pri problemih, kjer imamo opravka s šumnimi podatki, saj postopek abstrakcije poskrbi za neke vrste glajenje podatkov in s tem zmanjša vpliv šuma na rezultate.

Rezultat algoritma je množica vzorcev in pravil, ki opisujejo značilno obnašanje uporabnikov. Ta pravila omogočajo boljše razumevanje in preučevanje dogajanja v opazovanem sistemu.

Algoritem smo preizkusili na simulaciji, ki je bila razvita v ta namen in je na kratko opisana v prispevku. Kljub preprostosti same simulacije metoda uspe najti v podatkih pomembne vzorce in uspešno zgradi smiselna pravila.



CROWD BEHAVIOUR ANALYSIS

ALEŠ TAVČAR, UNIV. DIPLOM. INŽ. RAČ. IN INF.

DAMJAN KUŽNAR, UNIV. DIPLOM. INŽ. RAČ. IN INF.

ŠTUDIJSKI PROGRAM: INFORMACIJSKE IN KOMUNIKACIJSKE TEHNOLOGIJE,

MEDNARODNA PODIPLOMSKA ŠOLA JOŽEFA STEFANA

MENTOR: PROF. DR. MATJAŽ GAMS

SOMENTOR: DR. MITJA LUŠTREK

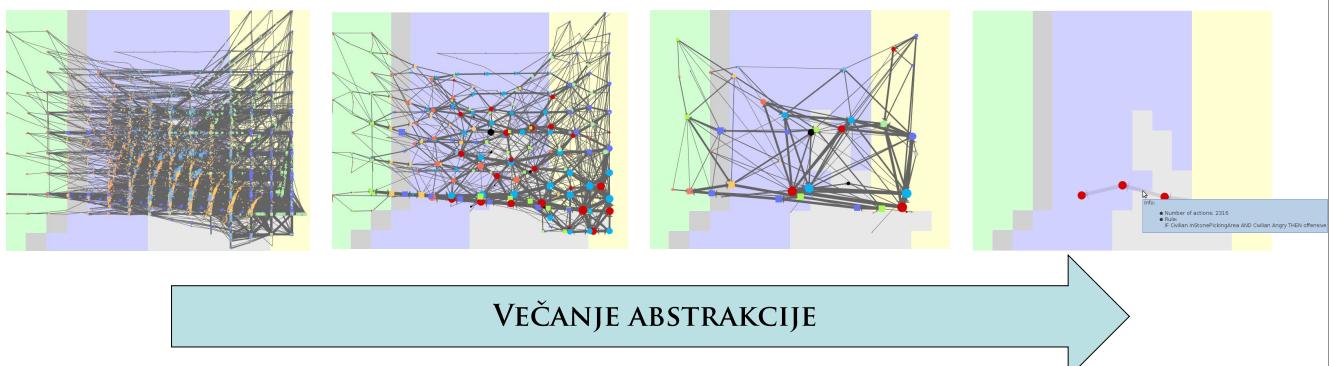
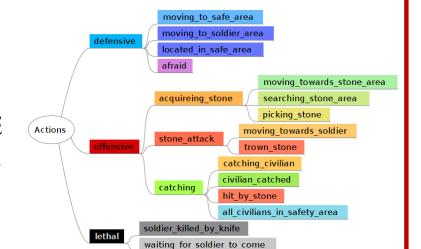
INŠITITUT JOŽEF STEFAN, JAMOVA CESTA 39, 1000 LJUBLJANA

MODELIRANJE OBNAŠANJA

- LE NA PODLAGI OPAZOVANJ DINAMIČNEGA, VEČ-AGENTNEGA SISTEMA UGOTOVITI, KAKŠNE SO PREVLADUJOČE STRATEGIJE
- MODELIRANJE OBNAŠANJA LJUDI ZAHTEVA TUDI UPOŠTEVANJE NJIHOVEGA KOGNITIVNEGA STANJA
- UPOŠTEVANJE DINAMIČNOSTI IN RAZNOLIKosti SISTEMA: LJUDJE SEKVENC AKCIJ NE PONAVLJajo DOSLEDNO, ČEPRAV ŽELijo DOSEČI ISTE CILJE

ALGORITEM

- VHOD: SLED IZVAJANJA VEČ-AGENTNEGA SISTEMA, DOMENSKO ZNANJE V OBLIKI ONTOLOGIJ
- S HIERARHIČNIM ZDRUŽEVANJEM SE INDUCIRA MODELE AGENTNEGA DELOVANJA, KI SO POSLEDICA IZVRŠEVANJA DOLOČENE STRATEGIJE
- REZULTAT: MNOŽICA VZORCEV OBNAŠANJA IN SIMBOLNA PRAVILA, KI VZORCE OPISUJEJO



PRAKTIČNA UPORABA

- ANALIZE DINAMIČNIH SISTEMOV, KI JIH LAJKO PREDSTAVIMO Z VEČ-AGENTnim SISTEMOM:
 - OBNAŠANJE UPORABNIKOV V RAČUNALNIŠKI MREŽI
 - MODELIRANJE NAVAD UPORABNIKOV PROGRAMSKIH PAKETOV
 - INTERAKCIJE UPORABNIKOV SOCIALNIH OMREŽIJ

WSN Testbeds for Lighting Control and Environmental Monitoring

Matevz Vučnik¹, Carolina Fortuna¹, Maria Porcius¹, Mihael Mohorčič^{1,2}

¹ Department of Communication Systems, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

firstname.lastname@ijs.si

Wireless sensor networks have a big potential in many different fields. We described in this paper some applications mainly focusing on environmental monitoring.

Wireless sensor networks are supposed to be low-power so that they can operate using batteries and optionally solar power. The networks consist of sensor nodes which are small embedded computers incorporating measuring capabilities and communication interface and are able to interoperate by each other.

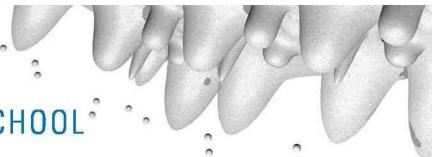
In all our testbeds, we are using a sensor node developed at the Department of Communication Systems, Jožef Stefan Institute in collaboration with Isotel d.o.o. It is called the Versatile Sensor Node because it is a highly reusable sensor node as we show in this paper. It is suitable for a large variety of applications with varying constraints.

We are building and adapting embedded and server side software too in such way that we can efficiently scale VSN deployments, accommodate heterogeneous sensors, collect data and meta-data, process them in real time and support high added value applications. Sensor networks are interesting especially because they leverage integration of the physical and virtual (i.e. Web) worlds. In the future, we can expect wireless sensor nodes all around us generating high amounts of data which are then processed with advanced algorithms extracting knowledge out of these data and then sending the commands to the actuators depending on the situation.



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ADVISOR: doc. dr. MIHAEL MOHORČIČ

¹Jožef Stefan International Postgraduate School

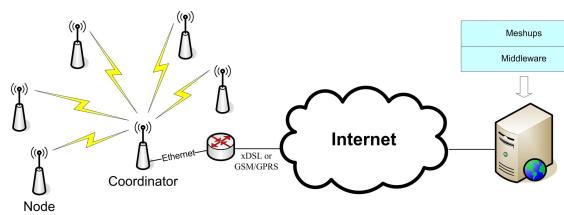
Study program: Information and Communication Technologies

²Department of Communication Systems, Jožef Stefan Institute, Jamova cesta 39, 1000 Ljubljana



TESTBED ARCHITECTURE

- This poster introduces new outdoor testbeds for wireless sensor networks (WSN) which gather data from the environment. The biggest testbed currently consists of 15 sensor nodes attached to public light poles that control the LED lights and measure temperature, humidity, pressure, luminance and battery voltage.
- Testbed is planned to grow to 100 nodes by late 2011.
- Poster focuses on two out of the three functional blocks of such a testbed: the network of sensors and the middleware.
- All testbeds are based on Versatile Sensor Node (VSN) which is a fully modular WSN platform.
- The data are gathered, processed, stored and exposed by the middleware (MySQL, GSN).



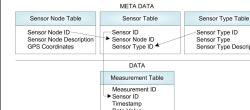
THE NETWORK OF SENSORS

- Hardware:
 - Powerful 32 bit microcontroller with low-power ARM Cortex-M3 core.
 - Microcontroller is STM32F103 with maximum clock frequency of 72 MHz.
 - 64 kB of RAM and 512 kB of flash memory. Additional 128 kB of fast FRAM and the possibility to use miniSD.
 - VSN supports digital interfaces such as I2C, SPI, UART, IrDA, RS232, USB and analog interfaces, 12 bit ADC and DAC.
- Various options of power supply:
 - mains, batteries, solar cells.
- Energy saving:
 - Three low-power states sleep, stop and standby.
 - Additional low-power state deep hibernation which consumes below 7µA.
- The radio is XBee-PRO which works in the ISM 868 MHz frequency band.
- The network topology is a star, based on a polling protocol which collects the measurements from the sensors each 30 seconds.
- Based on luminance measurements the dimming of the LED light is controlled.



THE MIDDLEWARE

- Centralized measurement storage is implemented by MySQL database server.
- The database design is closely related to the hardware design.
- The schema is designed to be minimalistic and to separate the meta-data stores from the measurements store in order to allow efficient use of semantic and data mining technologies.
- Each measurement can be linked back to the sensor and the node at any time.



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|---------------------|---|
| Real Name | Address |
| vse_state | battery_level: 375.0 temperature: -29.0000 humidity: 99.0000 pressure: 0.0 luminance: 0.06 luminance_x: 234.06 |
| kočanjevec-183 | Real Name Address Structure Description Download |
| vse_state | battery_level: 375.0 temperature: -29.0000 humidity: 99.0000 pressure: 0.0 luminance: 0.06 luminance_x: 234.06 |
| Kočanjevec-183 | Real Name Address Structure Description Download |
| vse_state | battery_level: 375.0 temperature: -29.0000 humidity: 99.0000 pressure: 0.0 luminance: 0.06 luminance_x: 234.06 |

OTHER TESTBEDS

1. Hyperthermia detection in stables

The goal is to measure temperature and humidity inside and outside stables. This information is enriched with information about calves, cows and amount of produced milk that are measured in a traditional manner.

2. Remote observation of sport-fishing conditions

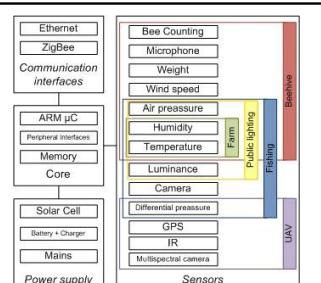
By using WSN technology information on water level, picture of a fishing spot and water and outside temperature can be provided.

3. Beehive local climate conditions

The purpose of this testbed is to monitor climate conditions inside (temperature and humidity) and outside (temperature, humidity, air pressure, wind direction and speed) of the beehives. Through bee counting sensor presence of pesticides in the vicinity can be detected. For the test purposes also sound monitoring is possible.

4. Multispectral imaging and data harvesting over Unmanned Aerial Vehicle (UAV)

Data harvesting over large areas where deployed WSNs have no Internet connection can be a very time consuming and expensive task. Our solution uses Unmanned Aerial Vehicles (UAV) equipped with a gateway sensor node. In addition, UAV is used to collect multispectral images with a Tetracam ADC camera.



The authors would like to thank SensorLab for its support.
sensorlab.ijs.si

Nanoznanosti in nanotehnologije (Nanosciences and Nanotechnologies)

Dielectric investigations of a new class of relaxor polymer

Andreja Eršte^{1,2}, Vid Bobnar¹, Xian-Zhong Chen³, Cheng-Liang Jia³, Qun-Dong Shen³

¹ Condensed Matter Physics Department, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

³ Department of Polymer Science and Engineering and Key Laboratory of Mesoscopic Chemistry of MOE, School of Chemistry and Chemical Engineering, Nanjing University, Nanjing, China

andreja.erste@ijs.si

Relaxor polymers are of great interest for a broad range of applications (e.g., actuators, sonars and artificial muscles) as they exhibit giant electromechanical response, which is several orders of magnitude larger than in classical piezoelectric ceramics. The input electric energy that can be converted into strain energy during electromechanical application is directly proportional to the dielectric constant of the electroactive material. The dielectric investigations thus play a key role in optimization of these systems: In order to induce the desired strain with lower external electric fields it is namely necessary to develop systems with high values of the dielectric constant. Disordered ferroelectric polymers exhibit typical relaxor properties. These systems are composed of crystalline regions embedded in an amorphous matrix. This complicates the interpretation of the dielectric results: The relaxor dynamics in the crystalline regions and the glassy transition in the amorphous matrix occur in the same temperature range and thus superimpose in the detected response. In order to investigate both processes separately, we performed high-resolution dielectric measurements of a new class of relaxor polymer, synthesized via reductive dechlorination from the P(VDF-TrFE-CTFE) system. Here, in the reduced P(VDF-TrFE) copolymer, the relaxor and glassy dynamics can be studied separately, as the relaxor peaks take place at much higher temperatures (80–130°C) than in the previously reported relaxor polymers. Our investigations revealed that (i) dielectric dynamics (linear and nonlinear) in relaxor polymers indeed is almost identical to that observed in classical relaxor systems and, furthermore, reminiscent of the dynamic behaviour observed in various spin glasses; (ii) even low bias voltage effectively blocks the ac electrical conductivity of the studied copolymer; and, more generally, that (iii) nonlinear dielectric susceptibility dominantly influences the dielectric dynamics of relaxors in dc bias electric fields. Increasing of the dielectric constant represents a major challenge in the development of electromechanical applications, in which the input electric energy that can be converted to strain energy is directly proportional to the dielectric constant of the electroactive material. In order to further the optimization of relaxor VDF-TrFE-based polymers, detailed dielectric investigations were performed in a new class of relaxor polymer, the reduced P(VDF-TrFE) copolymer, and the results have been published in Physical Review B 81, 214103 (2010), and, just recently (April 22, 2011), in Physical Review B 83, 132105 (2011).

Dielectric investigations of a new class of relaxor polymer

Andreja Erste^{1,2,*}, Vid Bobnar¹, Xian-Zhong Chen³, Cheng-Liang Jia³, Qun-Dong Shen^{3,†}

¹ Condensed Matter Physics Department, J. Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Nanosciences and Nanotechnologies, 2nd year; Supervisor: Asst. Prof. Dr. Vid Bobnar

³ Department of Polymer Science and, School of Chemistry and Chemical Engineering, Nanjing University, China



Motivation

Relaxor polymers exhibit **giant electromechanical response**, which is several orders of magnitude larger than in classical piezoelectric ceramics

interesting for

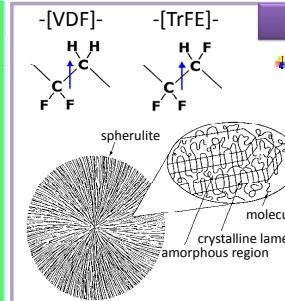
electromechanical applications
artificial muscles
actuators
sonars

The input electric energy that can be converted into strain energy during an electromechanical application is directly proportional to the dielectric constant of the electroactive material.

Dielectric investigations play a key role in optimization of these systems:

develop systems with higher values of ϵ'

induce desired strain with lower external electric fields



Relaxor polymers

Disordered relaxor polymers exhibit typical relaxor properties.

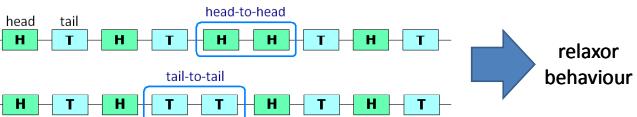
These systems are composed of crystalline regions embedded in an amorphous matrix:

Relaxor dynamics in the crystalline regions and glassy transition in the amorphous matrix superimpose in the detected dielectric response.

New class of relaxor polymer – separation of dynamic processes

Reduced P(VDF-TrFE) copolymer: synthesised via reductive dechlorination from P(VDF-TrFE-CTFE) terpolymer.

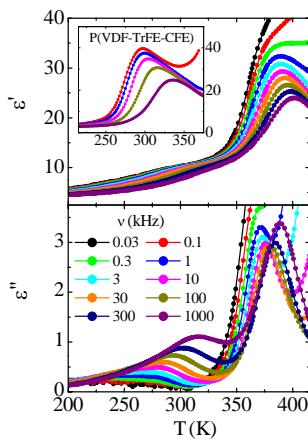
Large content of H-H and T-T defects (due to synthetic process):



In this system: relaxor and glassy processes can be separated.

Measurements of the linear dielectric response

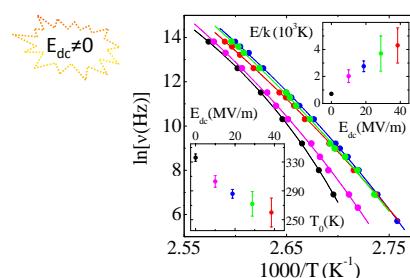
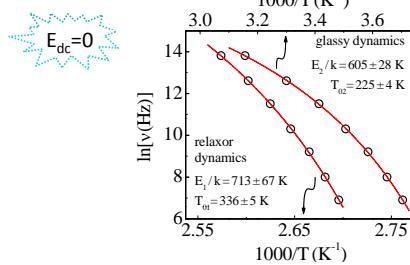
(temperature, frequency dependent; without and in dc bias field)



Temperature dependent dielectric response of the reduced P(VDF-TrFE) copolymer in zero bias electric field. For comparison, the inset shows the response of the classical relaxor polymer, the P(VDF-TrFE-CTFE) terpolymer.

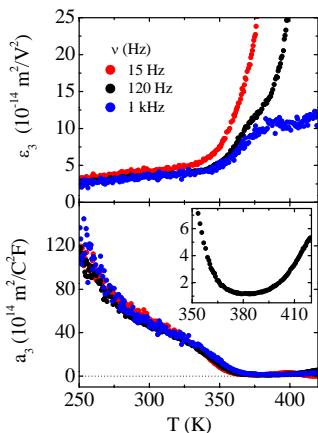
Analysis of dynamics

(Vogel-Fulcher behaviour)



Insets show the electric field dependence of the activation energy and Vogel-Fulcher freezing temperature.

Measurements of the nonlinear dielectric response



The nonlinear dielectric constant ϵ_3 and dielectric nonlinearity a_3 vs temperature. The inset shows a paraelectric-to-glass crossover in the $a_3(T)$, a feature typical for relaxor systems.

➤ **Macroscopic dielectric properties of the reduced P(VDF-TrFE) copolymer are identical to those observed in inorganic relaxors and reminiscent of the dynamic behaviour observed in various spin glasses.**

Phys. Rev. B. 81, 214103 (2010)

➤ **The nonlinear contribution dominantly influences the dynamics of relaxors in dc bias electric fields.**

Phys. Rev. B. 83, 132105 (2011)

* Electronic address: andreja.erste@ijs.si

† Information on material: qdshen@nju.edu.cn

Single nanoparticle detection in live cell by fluorescence microspectroscopy

Maja Garvas^{1,2}, Polona Umek¹, Janez Štrancar^{1,2}

¹ Condensed Matter Physics, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

Supervisor: Assoc. Prof. Dr. Janez Štrancar

maja.garvas@ijs.si

The number of different applications of nanomaterials is dramatically increasing, especially in the fields of chemical, food, cosmetic and electronic industries, as well as in environmental technology and medicine. Although nanotechnology brings success in many fields, exact impact of used material on human health and the environment is still not known. Nanomaterial characteristics, such as size, surface charge, chemical composition, play a role when particles and human cells meet. They influence strongly how particles pass the membrane or attach to it, pass nucleus or even parts of tissues and organs like human skin, lungs, gastrointestinal tract. Despite nanoparticle property - aggregation of nanoparticles, they can actually be identified inside the cell. This is a strong reason to further investigate nanoparticle-cell interaction.

To provide new insight into the nanoparticle uptake, we built the system which allows us to detect fluorescently marked nanoparticles within the cells despite they cannot be spatially recognized under optical microscope (due to small size, which is under optical resolution). Instead, the identification is done by detecting fluorescence emission spectra at every point of the image with the ability of monitoring the processes in real time in live cell samples. The system combines confocal fluorescence microscopy with fluorescence spectroscopy within one system, fluorescent microspectrometer (FMS).



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Single nanoparticle detection in live cell by fluorescence microspectroscopy

MAJA GARVAS, B.Sc.

Programme of study: Nanoscience and Nanotechnologies, Jozef Stefan International Postgraduate School

SUPERVISOR: Assoc. Prof. Dr. Janez Strancar

Laboratory of Biophysics, Institute Jozef Stefan, Ljubljana



AIM

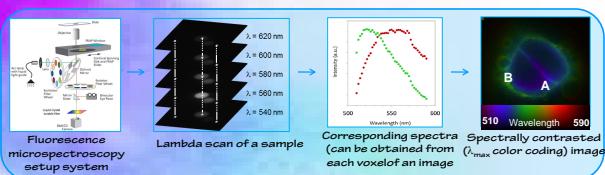
Different nanomaterials are nowadays widely applied in chemical, food, cosmetic and electronic industry, as well as environmental technology and medicine. On one side fantastic potential of nanomaterial and on the other side fear of unknown consequences drive the research groups to understand the mechanism of interaction of nanoparticles with different biological systems. Most of studies are biophysicochemical oriented (effect of size, shape, composition and surface charge,...)

FLUORESCENCE MICROSCOPING

To provide new insight into the nanoparticle uptake, we built the system which allows us to detect fluorescently marked nanoparticles within the cells despite they cannot be spatially recognized under optical microscopy. The identification is done via detecting fluorescence emission spectra in every voxel of the image in real time in live cell samples. The system combines confocal fluorescence microscopy with fluorescence spectroscopy within one system, fluorescent microspectrometer (FMS).

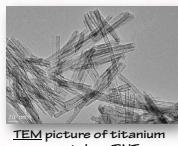
Detection of single nanoparticle

Observing mechanisms of nanoparticles passage through cell membrane into the live cell in real time becomes more demanding if we want to obtain information about single nanoparticle with its size significantly under the resolutions of optical methods.

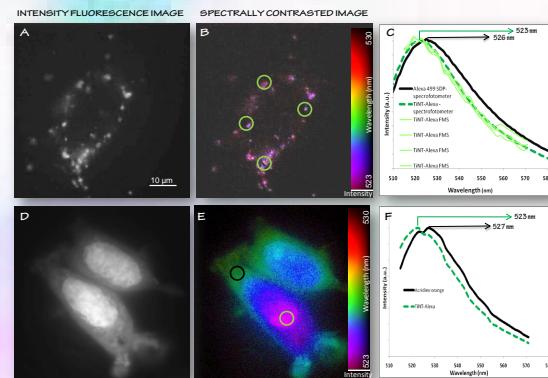
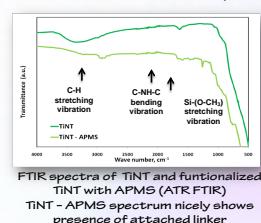
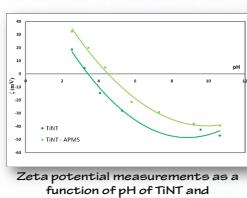
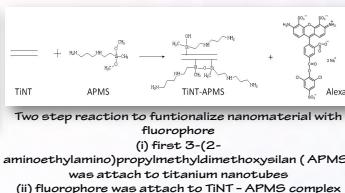


RESULTS

MATERIAL FUNCTIONALIZATION AND CHARACTERIZATION



Hydrothermal synthesize



MICROSCOPY RESULTS

CONCLUSIONS

- An important step was done in nanomaterial functionalization (stability of the label binding to the nanoparticles)
- FMS allows the spectral-based identification of nanoparticles within the cells, normal fluorescent microscopy can not (size of nanoparticle is significantly under the resolutions of optical methods)
- FMS is the right tool for the study the mechanism of interaction of single nanoparticle with live cell in real time

Interaction of titanium nanoparticles with living cells:
A Intensity image cannot discriminate between unbound fluorescent molecules and labelled single nanoparticles.

B Spectrally contrasted image (λ_{max}) can detect small shift in fluorescence emission spectra, which proves binding of a fluorophore to a linker. FMS spectra taken from different region of an image (green circles) coincide with results taken by spectrophotometer (C).

C Cell incubated *in vitro* with fluorescently labeled TINT for one day, before imaging for cell localization cell probe (acridine orange) was added (D,E).

D From fluorescence intensity contrasted images it is not possible to determine localization of nanoparticles due to overlap of fluorescent emission spectra of the nanoparticles and the cell probe. Spectrally contrasted image shows the distribution of the cell probe - acridine orange (blue/green) and labeled nanoparticles - Alexa (violet/pink) (E). Corresponding FMS spectra taken from different region of an image (circles) showing small shift in fluorescence emission spectra (F).

Processing of High-quality KTaO_3 Ceramics

Sebastjan Glinšek^{1,3}, Barbara Malič^{1,3}, Elena Tchernychova¹, Cene Filipič², Marija Kosec^{1,3}

¹Electronic Ceramics Department, Jožef Stefan Institute, Ljubljana, Slovenia ²Condensed Matter Physics, Jožef Stefan Institute, Ljubljana, Slovenia

³Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

sebastjan.glinsek@ijs.si

The progress of modern wireless communication technology is very fast and the market is quickly expanding. Near-future microwave devices should be highly adaptable, have higher information densities, increased speed of data transfer and have reduced size as well as costs. A strong market demand for electronically tunable capacitors, i.e. varactors, including those based on ferroelectrics, therefore exists.

The ferroelectric material should have a large enough tunability, defined as the ratio between the dielectric permittivity ϵ' at zero applied DC electric field to the permittivity at some selected field, which is directly correlated to the high permittivity value. At the same time the material should have low dielectric losses $\tan\delta$ at operating frequencies (microwave range). In order to avoid losses and hysteresis arising from the domain wall motions, ferroelectrics are preferably used in their paraelectric phase. When considering dielectric losses, single-crystals are the most obvious choice for the applications; on the other hand, ceramics are the cost-efficient alternative. In recent years a lot of research activities have focused on ferroelectric thin films due to miniaturization of electronic components, easier integration and much lower tuning voltages compared to bulk materials.

Our research involves a broad field of preparation and characterization of the ceramics and thin films of incipient ferroelectric KTaO_3 , as well as its solid solution with ferroelectric KNbO_3 . We are preparing the ceramics by solid-state synthesis and thin films by chemical solution deposition. Our aim is to establish the correlation between the dielectric properties and the synthesis conditions. Further on, we want to evaluate the influence of grain boundaries on the dielectric permittivity ϵ' value and the influence of the strain on dielectric properties in KTaO_3 polycrystalline films. The knowledge of these correlations will result in improved functional properties of the ceramics and thin films.



sebastjan.glinsek@ijs.si



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Sebastjan Glinšek¹, Barbara Malič¹, Elena Tchernykhova¹, Cene Filipič², Marija Kosec¹

¹Electronic Ceramics Department, Jožef Stefan Institute, Ljubljana, Slovenia

²Condensed Matter Physics, Jožef Stefan Institute, Ljubljana, Slovenia

student: **Sebastjan Glinšek**; programme: Nannoscience and Nanotechnologies; supervisor: **prof. Marija Kosec**

Introduction

Incipient ferroelectrics are materials whose dielectric permittivity ϵ' continuously increases with decreasing temperature. As quantum fluctuations prevent dipole ordering at low temperatures they do not experience a paraelectric–ferroelectric phase transition. Therefore they have a high dielectric permittivity and at the same time low dielectric losses $\tan\delta$, especially at cryogenic temperatures. They are of special interest for **microwave components** which are integrated into modern wireless devices.

KTaO_3 is one of the prototype incipient ferroelectrics with well-known properties in its single-crystal form. On the other hand, reports on KTaO_3 ceramics, which are technologically interesting, are very limited. We have prepared KTaO_3 ceramics with dielectric properties comparable to single-crystals by implementation of the mechanochemical activation of the starting powder mixture into the solid-state synthesis.

Experimental & Results

Synthesis

Starting compounds: K_2CO_3 (99+, Sigma-Aldrich) + Ta_2O_5 (99%, Alfa Aesar).

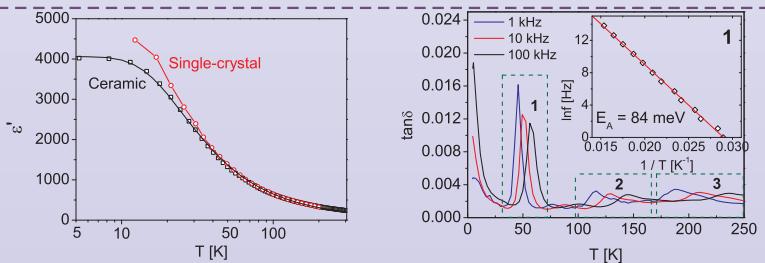
Mechanochemical activation: **high-energy milling** performed in Videlia vial and milling balls using planetary mill; disk and the vial rotational frequencies were set to 350 min^{-1} and 700 min^{-1} , respectively, and the high-energy milling was performed for 10 h.

Calcination: activated powders were **heated at 800°C for 4 h**; **second calcination** was performed at the same temperature. After each calcination step the powder was milled in a polyethylene vial with YSZ milling balls at 175 min^{-1} for 4 h. Acetone was used as a milling medium.

Sintering: powder compacts were packed in coarse MgO powder in an alumina die and **hot-pressed at 1250°C for 2 h**.

Perovskite powders (XRD analysis) powders consist of cuboidal particles with sizes ranging from $\sim 100 \text{ nm}$ to $\sim 500 \text{ nm}$. Nanoparticles with sizes $5 \text{ nm} - 20 \text{ nm}$ are attached to larger particles in the single-calcined powders.[Tchernykhova et al., JACerS, 2010] These nanoparticles are crystalline as well as amorphous and their chemical composition varies significantly. **The homogeneity was improved during the second calcination.**

Perovskite KTaO_3 ceramics, prepared from the **double-calcined powders**, have relative densities of $\sim 95\%$ and a bimodal grain size distribution. Larger grains can exceed $3 \mu\text{m}$ in size, between them smaller grains are situated inside the porous regions. The average grain size is in the order of $1 \mu\text{m}$.



The dielectric permittivity ϵ' of the KTaO_3 ceramic measured at 100 kHz and single-crystal calculated from the hyper-Rayleigh spectra.[Vogt, PRB, 1990]]

Permittivity ϵ' of the ceramics increases from 240 at room temperature to ~ 4000 below 10 K . Very similar behaviour was reported for the **high-quality single-crystal**, with only slightly higher **low temperature permittivity**, i.e. ~ 4500 .[Vogt, PRB, 1990]]

Three frequency dispersion regions are present in the loss-spectrum. All of them follow the Arrhenius law, with their E_A values of 84 meV , 225 meV , and 370 meV . The first one is typically reported for the KTaO_3 single-crystals and is related to an intrinsic lattice defect or unavoidable impurity. The origin of the second dispersion region is presently unclear, while the third one originates from the Co^{2+} impurity.[Glinšek et al., JACerS, 2010]

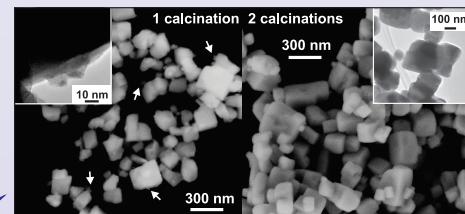
Conclusions

- ⇒ The key step in the processing is double calcination of the KTaO_3 powders at 800°C , which contributes to enhanced homogeneity of the powders.
- ⇒ Dielectric permittivity of the KTaO_3 ceramics, with relative density of 95 % and grain size in the order of $1 \mu\text{m}$, is only slightly lower than in single-crystals.

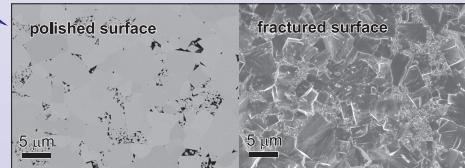
Characterization

Microstructures: field emission scanning microscopes (FE-SEM) Supra 35 VP (Carl-Zeiss) and JSM-7600F (JEOL); transmission electron microscope (TEM) JEM-2010F (JEOL).

Dielectric properties: Novocontrol Alpha High Resolution Dielectric Analyzer (Novocontrol Technologies)



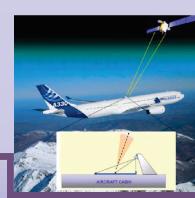
FE-SEM micrographs of the powders after one and two calcinations at 800°C for 4 h. Detailed TEM micrographs are shown in the insets.



FE-SEM micrographs of the polished and fractured surfaces of the KTaO_3 ceramics obtained by back-scattered and secondary electrons imaging modes, respectively.

Applications

- ⇒ In modern wireless communication technology operating in the microwave frequency range; as **electronically tunable capacitors**, i.e. varactors.
- ⇒ Main functional properties: **strong electric field dependence of dielectric permittivity ϵ'** ; **low dielectric losses $\tan\delta$** .
- ⇒ Attractive as ceramics and thin films.
- ⇒ Example of the device: **phase shifters** in electronically steerable antenna; due to its 2D geometry it is especially convenient for aeronautical applications.



Acknowledgements

Research has been supported by the Slovenian Research Agency (1000-07-310068, P2-0105). Dr. Marjan Bele is acknowledged for the access to the FE-SEM.

Priprava stolpičastih struktur CoFe_2O_4 pod vplivom magnetnega polja

Petra Jenuš^{1,2}, Darja Lisjak¹, Darko Makovec¹, Miha Drofenik^{1,3}

¹ Odsek za sintezo materialov, Inštitut Jožef Stefan, Ljubljana, Slovenija

² Mednarodna podiplomska šola Jožef Stefan, Ljubljana, Slovenija

³ Fakulteta za kemijo in kemijsko tehnologijo, Maribor, Slovenija

petra.jenus@ijs.si, darko.makovec@ijs.si (mentor)

Raziskave na Odseku za sintezo materialov so usmerjene v razvoj naprednih oksidnih materialov, ki izkazujejo uporabne elektromagnetne lastnosti. Namen raziskav je pridobiti znanje o kemiji materialov, kar omogoča načrtovanje novih materialov z želenimi lastnostmi. Pridobljeno znanje o kontrolirani sintezi osnovnih materialov nadgrajujemo z znanjem o prilagajanju njihovih kemijskih lastnosti za sintezo sestavljenih in/ali večfunkcionalnih materialov. Na odseku tako raziskujemo materiale za uporabo v elektroniki, telekomunikacijah, medicini, tehniki, ekologiji.

Obvladovanje površinskih lastnosti nanodelcev nam omogoča pripravo nanokompozitov, ki kombinirajo različne uporabne lastnosti materialov, ki jih vsebujejo. Predvsem gre za kombinacijo ferimagnetičnih materialov in dielektrikov (magnetodielektrikov) ali feromagnetičnih in feroelektričnih materialov (kompozitnih multiferoikov). V okviru razvoja novih magnetooptičnih materialov študiramo mehanizme kristalizacije magnethnih delcev v različnih optično prozornih matricah ter vpliv magnethnih lastnosti delcev in zunanjega magnetnega polja na optične lastnosti. Ti sestavljeni materiali so osnova naprednih magnetooptičnih senzorjev. S prevlečenjem magnethnih nanodelcev z nanodelci TiO_2 sintetiziramo magnethno odzivne fotokatalitske nanokompozitne delce, ki se uporabljam za čiščenje onesnaženih voda in plinov.



PRIPRAVA STOLPIČASTIH STRUKTUR CoFe_2O_4 POD VPLIVOM MAGNETNEGA POLJA

Petra Jenuš, uni.dipl.ing.kem.tehn.

Mednarodna podiplomska šola Jožefa Stefana

Študijski program: Nanoznanosti in nanotehnologije

Mentor: prof.dr. Darko Makovec

Raziskovalni mentor: doc.dr. Darja Lisjak

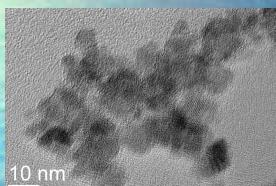
Inštitut Jožef Stefan, Jamova cesta 39, Ljubljana

priprava stolpičastih struktur kobaltovega ferita

NAMEN:

VZOREC A

- Soobarjanje
- Delci CoFe_2O_4 stabilizirani s citronsko kislino
- Stabilna vodna suspenzija



Povprečna velikost delcev CoFe_2O_4 je 10 nm

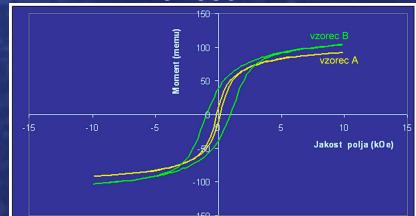
Morfologija nanosov, vzorec A

osnova za magneto-električne (ME) nanokompozite

NANOSI

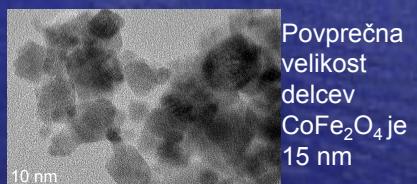
- Stabilni suspenzioni kobaltovega ferita
- Magnetno polje ($B = 0,7 \text{ T}$)
- Sobna temperatura
- Organska snov odstranjena s segrevanjem na 460°C , 2h

Magnetne meritve nanosov



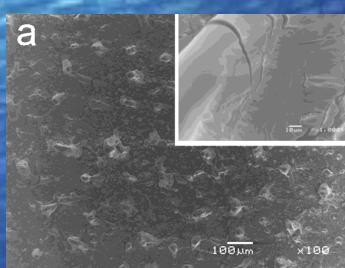
VZOREC B

- Hidrotermalna sinteza
- Delci CoFe_2O_4 stabilizirani z dodecilbenzil sulfonsko kislino (DBSA)
- Stabilna butanolna suspenzija



Povprečna velikost delcev CoFe_2O_4 je 15 nm

Morfologija nanosov, vzorec B



ZAKLJUČKI

- Po sušenju pri sobni temperaturi pod vplivom magnetnega polja in odstranitvi organske faze nastanejo stolpičaste strukture kobaltovega ferita
- Nastale vertikalne strukture izkazujejo (fero)magnetne lastnosti

V nadaljevanju jih bomo uporabili kot eno izmed faz v ME nanokompozitih

UPORABA ME

POMNILNIKI



SENZORJI



PRETVORNIKI



Zahvala: To delo je finančno podprt s strani ARRS

Synthesis and characterisation of nano-TiO₂ particles with different techniques

Matic Krivec^{1,2}, Ricardo A. Segundo³, Rita R. N. Marques³, Goran Dražić^{1,2}

¹ Department of nanostructured materials, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

³ FEUP-Faculdade de Engenharia da Universidade do Porto, Porto, Portugal

matic.kriveck@ijs.si

Photocatalytic reaction with TiO₂ has become a well-known procedure for the remediation of different pollutants; the process is efficient, environmental-friendly and relatively cheap. The main requirement of this process is to ensure the illumination of TiO₂ with a proper energy source (UV light). While the solar spectrum contains only small amount of UV light (5 %) which is even smaller when the weather is cloudy, it is important to shift the photocatalytic activity towards the visible spectrum. In our research work, we will try to improve the photocatalytic activity and we will try to produce a very sensitive photocatalyst, which would efficiently oxidize different pollutants on the solar spectrum. Furthermore, our aim is to strongly attach the photocatalyst to some substrate to prevent the TiO₂ pollution. We would like to produce a microreactor with the TiO₂ coating on the inner surface of the reactor. The advantages of reactions at micro level favor the idea of TiO₂ implantation into microreactors; high surface-to-ratio area, higher heat and mass transfer, higher spatial illumination homogeneity and better light penetration through the entire reactor are just a few of several properties that make this procedure interesting in designing micro-cleaning devices. Moreover, the scale-up of this cleaning device can be easily done with parallel binding, without any restrictions in immobilization in comparison with the large-scale reactors.



Synthesis and characterization of nano-TiO₂ particles by different techniques



Matic Krivec, univ. dipl. biok.

Study programme: Nanoscience and nanotechnology

Jožef Stefan International Postgraduate School

Mentor: doc. dr. Goran Dražić

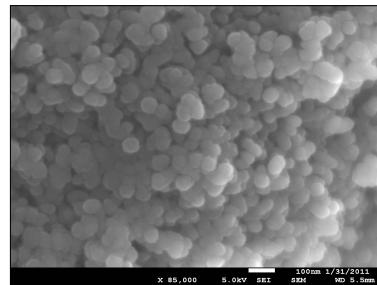
Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia



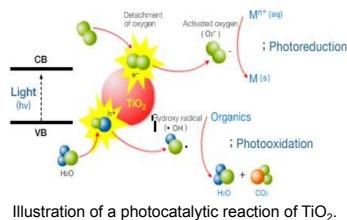
Introduction:

Titanium oxide is an inorganic material, which can be found in three crystal modifications: anatase (A), rutile (R) and brookite. TiO₂ is a semiconductor and it is widely used because of its photocatalytic properties.

Exposing the photocatalyst to an energy source (UV light) cause activation of electrons, which interact with water and oxygen and produce hydroxyl radicals and superoxide ions. These are efficient oxidants for several organic chemicals, even microorganisms and they offer many applicative possibilities in construction of cleaning devices.



FESEM image of rutile ellipsoids after peroxotitanium complex and calcination ($T=800\text{ }^{\circ}\text{C}$).



Aim:

- Preparation of well crystallized nano-TiO₂ particles with different precursors and techniques.
- Preparation of doped TiO₂ particles with smaller band gaps.
- Preparation of photocatalytic rutile particles at low temperatures.
- Characterization of samples with XRD, UV-Vis spectrophotometry and TEM.
- Characterization of photocatalytic activities of samples with SolarBox.

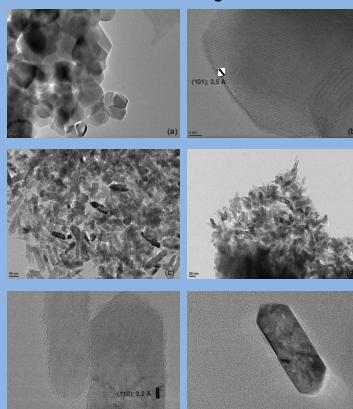
Results:

1. XRD and UV-Vis spectrophotometry

| Sample | Particle size (nm) | Band gap (eV) |
|----------------------------|--------------------|---------------|
| SG_isopropoxide_300 | A: 7 | n.m. |
| SG_isopropoxide_600 | A: 14 | n.m. |
| SG_isopropoxide_Ndoped_300 | A: 8 | n.m. |
| SG_isopropoxide_Ndoped_600 | A: 20 | n.m. |
| SG_isopropoxide_Sdoped_300 | A: 4 | n.m. |
| SG_isopropoxide_Sdoped_600 | A: 14 | 3,07 |
| SG_peroxotitanium | R: 46 | 3,07 |
| SG_peroxotitanium_Sdoped | A: 12 | 2,49 |
| HT_isopropoxide | A: 9 | n.m. |
| HT_isopropoxide_800 | A: 22 and R: 74 | n.m. |
| HT_isopropoxide_Ndoped | A: 9 | 3,23 |
| HT_isopropoxide_Ndoped_300 | A: 9 | 3,21 |
| HT_isopropoxide_Ndoped_500 | A: 11 | 3,19 |
| HT_isopropoxide_Ndoped_800 | R: 74 | n.m. |
| HT_isopropoxide_Sdoped | A: 7 | 3,18 |
| HT_isopropoxide_Sdoped_300 | A: 7 | 3,2 |
| HT_isopropoxide_Sdoped_500 | A: 8 | 3,23 |
| HT_isopropoxide_Sdoped_800 | A: 33 | 3,27 |
| HT_peroxotitanium | R: 39 | 3,07 |
| HT_peroxotitanium_Sdoped | A: 12 | 3,25 |
| HT_peroxotitanium_Ndoped | A: 17 | 3,26 |
| Degussa P25 | A and R: 21 | 3,33 |

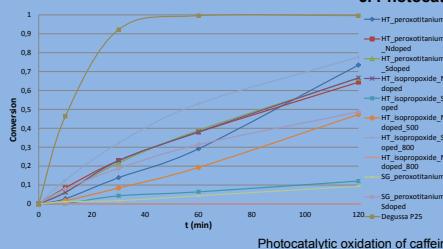
Average sizes of TiO₂ particles and their energy band gap values (A-anatase, R-rutile).

2. TEM images



TEM images of anatase (a, b) and rutile (c, d, e, f) particles prepared with different techniques: (a) and (b) HT_isopropoxide_800 °C; (c) SG_peroxotitanium; (d) and (e) HT_peroxotitanium; (f) HT_peroxotitanium_T_{cal}: 800 °C.

3. Photocatalytic activity



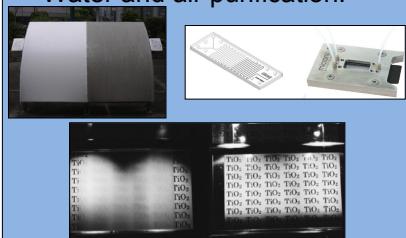
| | Crystal phase | Photocatalytic coefficient | Conversion (t = 120 min) |
|----------------------------|------------------|----------------------------|--------------------------|
| HT_isopropoxide_Ndoped | anatase | 7,5E-03 | 0,67 |
| HT_isopropoxide_Ndoped_500 | anatase | 2,7E-03 | 0,47 |
| HT_isopropoxide_Ndoped_800 | rutile | 0 | 0 |
| HT_isopropoxide_Sdoped | anatase | 1,3E-03 | 0,12 |
| HT_isopropoxide_Sdoped_800 | anatase | 1,1E-02 | 0,78 |
| SG_peroxotitanium | rutile | 6,0E-04 | 0,09 |
| HT_peroxotitanium_Sdoped | anatase | 6,4E-03 | 0,49 |
| HT_peroxotitanium | rutile | 4,4E-03 | 0,73 |
| HT_peroxotitanium_Ndoped | anatase | 7,7E-03 | 0,64 |
| HT_peroxotitanium_Sdoped | anatase | 7,1E-03 | 0,67 |
| Degussa P25 | anatase + rutile | 3,2E-02 | 1 |

Conclusions:

- Calcination of TiO₂ powders affects the size of the particles.
- The particles are growing according to the temperature of the calcination.
- Rutile particles are synthesized via peroxotitanium route at low temperature.
- Very small energy gap (2,49 eV) was observed in S-doped sample prepared from peroxotitanium precursor.
- Rutile particles synthesized at low temperature by a hydrothermal route exhibit high photocatalytic activity.

Applications:

- Self-cleaning surfaces.
- Self-sterilizing surfaces.
- Anti-fogging surfaces.
- Water and air purification.



Enhancing the materials for new generation of piezoelectric devices

Nikola Novak^{1,2} and Zdravko Kutnjak¹

¹ Department of Condensed Matter, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

nikola.novak@ijs.si

Piezoelectricity is a property of materials to transform electric energy to mechanical work and vice versa. This is very useful in many applications, for instant in smart electronic systems as sensors, actuators and motors or in the field of ultrasound imaging and telecommunication. The broad spectrum of technological possibilities to use the piezoelectric effect makes piezoelectric materials very interesting. In the last few decades, development and improvement of these materials have attracted considerable attention. One way to improve the piezoelectric response is to understand the basic principles which are responsible for enhancement of piezoelectric coefficient. For a long time the enhancement of piezoelectric response was attributed to morphotropic phase boundary and a polarization rotation mechanism. Recently, a new way to enhance the piezoelectric response was shown in which the influence of the electric field is taken into account. Specifically, by applying a sufficiently high electric field the system is brought to the proximity of liquid-vapour type critical point where maximum of the piezoelectric coefficient can be observed. It was theoretically shown that the enhancement of the piezoelectric coefficient is directly related to the divergence of the dielectric susceptibility tensor at critical point. Our investigation of piezoelectric response in the ferroelectric relaxor PMN-PT system close to the morphotropic phase boundary show that the enhancement of the piezoelectric coefficient is not predominantly related to the polarization rotation within the monoclinic phase sequence as previously thought. In contrast, it was observed that at the onset of the monoclinic phase sequence the critical piezoelectric response is greatly reduced.

Our studies reveal two new possibilities of improvement of piezoelectric response. One is to bring the system in the vicinity of critical point and another is to synthesise materials without or at least with very narrow temperature range of monoclinic phase sequence close to the morphotropic phase boundary.



ENHANCING THE MATERIALS FOR NEW GENERATION OF PIEZOELECTRIC DEVICE

Nikola Novak, prof. fiz. in PTHV

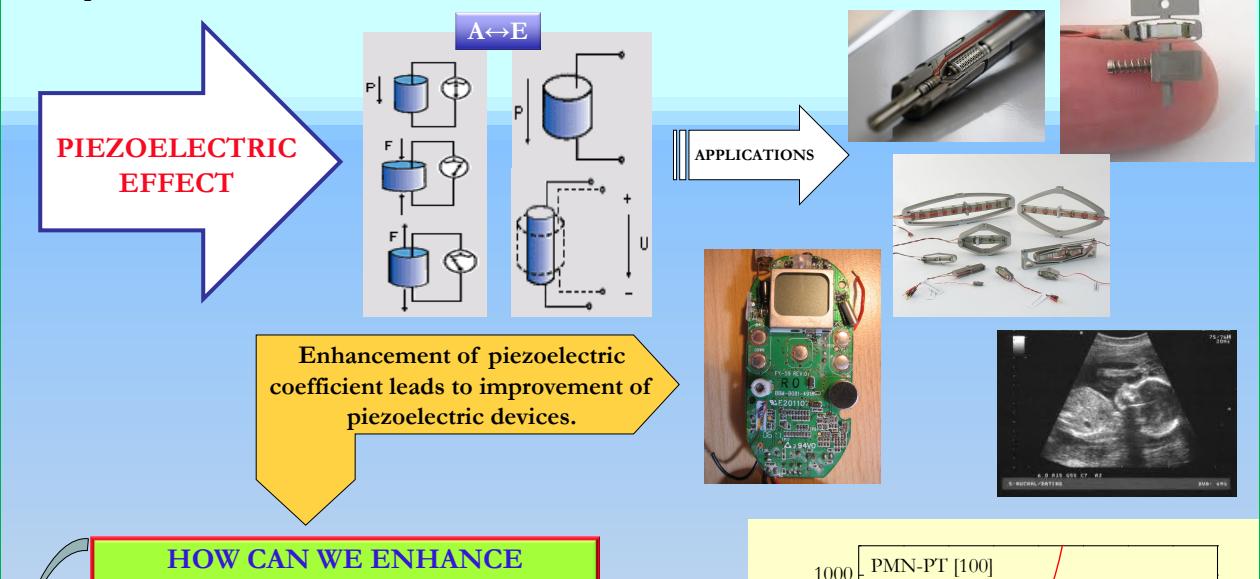
Jožef Stefan International Postgraduate School: Nanoscience and nanotechnologies,

MENTOR: prof. dr. Zdravko Kutnjak

Jožef Stefan Institute, Jamova cesta 39, 1000 Ljubljana, Slovenia

Abstract

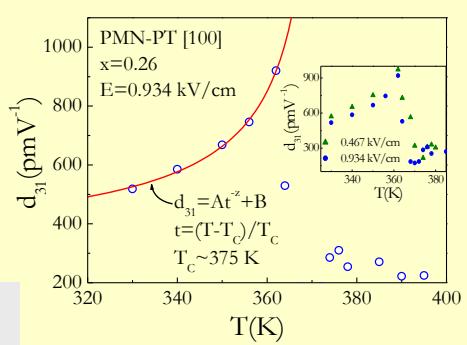
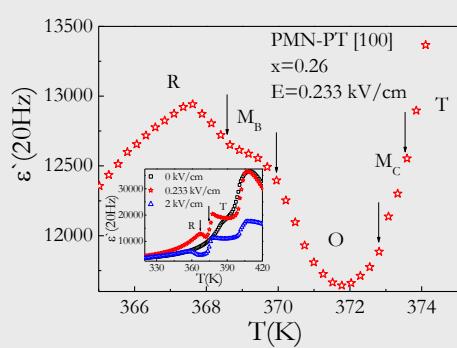
Piezoelectricity is a property of a material of direct conversion of electrical energy to mechanical work and vice versa. This is very useful to a number of applications, for instant in smart electronic systems as sensors, actuators and motors or in the field of ultrasound imaging and telecommunication. The broad spectre of technological possibilities to use the piezoelectric effect makes piezoelectric materials very interesting. Especially development and improvement of this material has attracted considerable attraction in last few decades.



HOW CAN WE ENHANCE PIEZOELECTRIC COEFFICIENT?

The material has to be engineered in such a way that it is brought to the vicinity of the critical point where the piezoelectric tensor diverges due to the divergence of the dielectric susceptibility [1-3]. The piezoelectric coefficient can be significantly enhanced up to an order of magnitude or even more.

Create a material without or at least with very narrow temperature range of intermediate monoclinic phase sequence between the R-T transition.



References

- [1] Z. Kutnjak, J. Petzel and R. Blinc, Nature **441**, 956 (2006).
- [2] Z. Kutnjak, R. Blinc and Y. Ishibashi, Phys. Rev. B **76**, 104102 (2007).
- [3] M. Porta, T. Lookman and A. Saxena, J. Phys.: Condens. Matter **22**, 345902 (2010).

Magnetne lastnosti nanodelcev Ba heksaferita ($\text{BaFe}_{12}\text{O}_{19}$) sintetiziranih s hidrotermalno sintezo

Darinka Primc^{1,2}, Miha Drofenik^{1,3}, Darja Lisjak¹, Darko Makovec¹

¹ Odsek za sintezo materialov, Inštitut Jožef Stefan, Ljubljana, Slovenija

² Mednarodna podiplomska šola Jožef Stefan, Ljubljana, Slovenija

³ Fakulteta za kemijo in kemijsko tehnologijo, Maribor, Slovenija

darinka.primc@ijs.si

Raziskave na Odseku za sintezo materialov so usmerjene v razvoj naprednih oksidnih materialov, ki izkazujejo uporabne elektromagnetne lastnosti. Namen raziskav je pridobiti znanje o kemiji materialov, kar omogoča načrtovanje novih materialov z želenimi lastnostmi. Pridobljeno znanje o kontrolirani sintezi osnovnih materialov nadgrajujemo z znanjem o prilagajanju njihovih kemijskih lastnosti za sintezo sestavljenih in/ali večfunkcionalnih materialov. Na odseku tako raziskujemo materiale za uporabo v elektroniki, telekomunikacijah, itd. Obvladovanje površinskih lastnosti nanodelcev nam omogoča pripravo nanokompozitov, ki kombinirajo različne uporabne lastnosti vsebovanih materialov. Predvsem gre za kombinacijo ferimagnetičnih materialov in dielektrikov (magnetodielektrikov) ali feromagnetičnih in feroelektričnih materialov (kompozitnih multiferoikov). V okviru razvoja novih magnetooptičnih materialov študiramo mehanizme kristalizacije magnetnih delcev v različnih optično prozornih matricah ter vpliv magnetnih lastnosti delcev in zunanjega magnetnega polja na optične lastnosti. Ti sestavljeni materiali so osnova naprednih magnetooptičnih senzorjev. S prevlečenjem magnetnih nanodelcev z nanodelci TiO_2 sintetiziramo magnetno odzivne fotokatalitske nanokompozitne delce, ki se uporabljam za čiščenje onesnaženih voda in plinov.



MAGNETNE LASTNOSTI NANODELCEV Ba HEKSAFERITA ($BaFe_{12}O_{19}$) SINTETIZIRANIH Z HIDROTERMALNO SINTEZO

Darinka Primc

univ. dipl. kem.

Mednarodna podiplomska šola inštituta Jožef Stefan,

Študijski program: Nanoznanosti in Nanotehnologije

Mentor: doc. dr. Darja Lisjak

Raziskovalni mentor: prof. dr. Darko Makovec

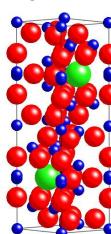
Inštitut Jožef Stefan, Jamova 39, Ljubljana

UVOD

- * Barijev heksaferit je trdo-magneten material ki se uporablja kot permanentni magnet, absorber EM valovanja in za mikrovalovne naprave



- * Za potrebe tehničnih aplikacij in za medicinske aplikacije jih je potrebno pripraviti v obliki stabilnih suspenzij
- * Potrebno je sintetizirati superparamagnete nanodelce

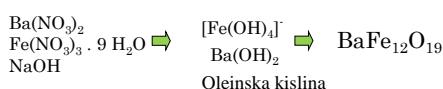


EXPERIMENT

- * Ba heksaferit v obliki nanodelcev lahko sintetiziramo z hidrotermalno sintezo



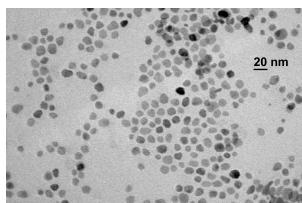
- * Hidrotermalna sinteza je primerna tudi za industrijsko uporabo



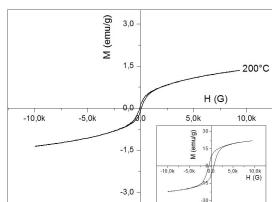
130-200 °C

REZULTATI

- * Sintetizirani nanodelci Ba heksaferita so v oblik okroglih ploščic premera 10 nm in debeline 3 nm.



- * Delci med seboj niso aglomerirani kar omogoča njihovo dispergiranje in pripravo magnetnih tekočin

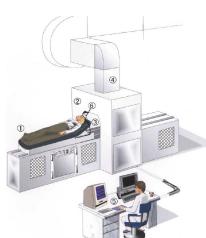


- * Sintetizirani delci izkazujejo superparamagnete lastnosti

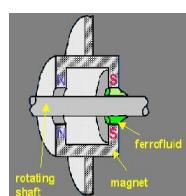
- * Zaradi majhne velikosti delci izkazujejo relativno šibke magnete lastnosti

APLIKACIJE

- * UPORABA V MEDICINI:
 - slikanje z NMR tehniko
 - hipertermija
 - ciljano dostavljanje



MAGNETNE SEPARACIJE



- * TEHNIČNE APLIKACIJE:
 - tesnenje
 - prenos topote
 - dušenje vibracij



IPSSC: Using a movable active element to control the density of neutral oxygen atoms in a plasma afterglow chamber

Gregor Primc^{1,2}, Miran Mozetič^{1,2}

¹ Department of Surface Engineering and Optoelectronics, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

gregor.primc@ijs.si

Although nowadays plasma is used in many applications (as mentioned in the introduction) the behaviour of the particles and inter-particle interactions are still not fully understood.

Our department is aimed towards basic and applied research on the field of low pressure gaseous plasmas and interactions between plasma radicals and solid surfaces. Research includes studies of gaseous discharges, coupling between plasma and discharge generator, plasma characterization, the interaction of charged and neutral particles with solid surfaces, and the analysis of plasma-modified materials.

Listed basic researches are the foundation for applicable researches on the field of environmentally friendly technologies. These technologies include plasma discharge cleaning, selective plasma etching, cold ashing of bio-materials, and sterilization of sensitive medical materials and the synthesis of nanomaterial.

The aim of my research is to build software driven control system that will allow us to sustain and to dynamically change the density of neutral atoms. In order to support this idea we have to monitor and control the discharge parameters and movable recombinators and simultaneously measure the density of plasma particles. Discharge parameters are output power and coupling of the generator, vacuum degree and gas flow, features of the plasma chamber and the specific properties of treated sample.

For monitoring of the density of plasma particles we will use catalytic probes, electric (Langmuir) probes, optical emission spectroscopy and mass spectroscopy methods.

The final goal of my research is to develop a plasma reactor with a stable and arbitrary neutral atom density, which will allow for an effective and controlled processing of materials.



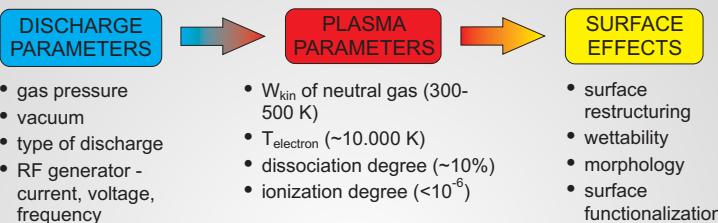
Using a movable active element to control the density of neutral oxygen atoms in a plasma afterglow chamber

INTRODUCTION

Systematic measurements of neutral oxygen atoms under various conditions and with the presence of a special active element (recombinator) were performed, mostly to establish atom density conditions for future work on the regulation and dynamic control of neutral oxygen atoms.

It has been found out that the density of neutral oxygen atoms depends both on the pressure of the inlet oxygen gas and exciting power, but mostly on the presence and the position of the recombinator. The measured densities are of the order of 10^{21} m^{-3} , which is a characteristic value in glass discharge chambers. Such orders of neutral oxygen atom densities suffice for treatment of organic materials. The problem with organic materials is that interaction with oxygen atoms heats the material. Therefore, it is often necessary to decrease the atom density as soon as possible to prevent heating of the material. As it is described in this poster work this is possible by using a movable recombinator, which enables us to select the appropriate atom density without having to change the discharge parameters.

Surface effects depend on plasma parameters!



HOWEVER ... !

Plasma parameters may change even when discharge parameters are fixed!

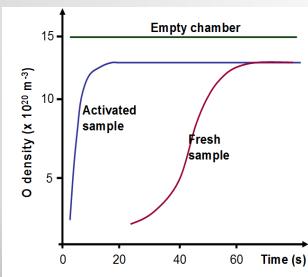
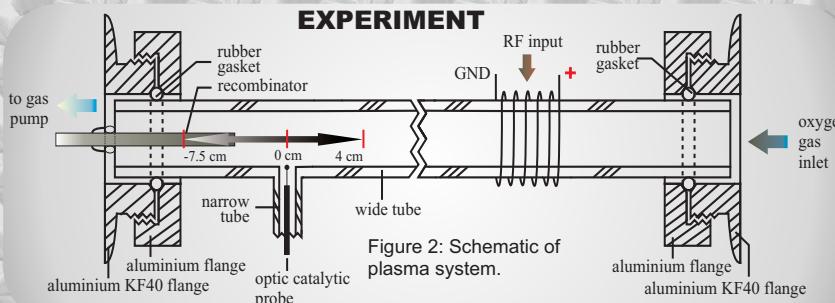


Figure 3: This graph shows neutral oxygen atom density in a glass chamber using oxygen plasma. The black curve shows a constant density when the chamber is empty. The blue curve shows neutral oxygen atom density when already activated sample is put into the chamber and the red curve represents density changes when a fresh sample is put into the chamber. At the beginning of treatment, fresh sample represents a sink for oxygen atoms and after a few ten seconds of treatment the sample saturates.

The difference in neutral oxygen atom density with or without the sample shows that the sample is still able to accept some oxygen atoms after the material has been restructured. The neutral oxygen atoms hit the sample and transfer their energy to it, therefore the sample heats and may be irreversibly damaged or even destroyed.



CONCLUSIONS

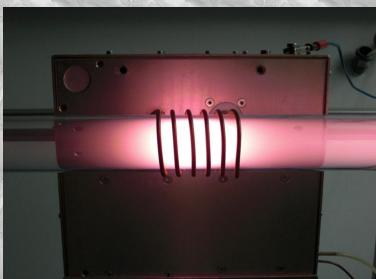
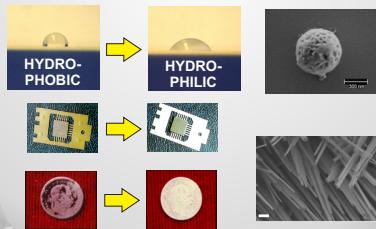
- recombinator mounted far from the probe
- recombinator mounted near the probe
- recombinator mounted over the probe
- shift of recombinator for only 1 cm

no change in neutral oxygen atom density
 slightly reduced neutral oxygen atom density
 up to an order of magnitude lower neutral oxygen atom density
 change in oxygen atom density for $\sim 10^{21} \text{ m}^{-3}$

Using our recombinator we were able to achieve desired neutral oxygen atom density in the plasma afterglow without changing any discharge parameters. Densities achieved are typical for organic material treatment. Material treatment in plasma is accompanied by useful restructuring and unwanted heating. The latter can cause severe damage to the sample, therefore knowing neutral atom density is very important.

How do we use highly dissociated weakly ionized cold oxygen plasma?

- Plasma cleaning represents environmental friendly alternative to harmful chemical cleaning methods
- Selective plasma etching
- Cold ashing of biological samples
- Sterilization of sensitive materials
- Surface functionalization
- Nanowire synthesis



RESULTS

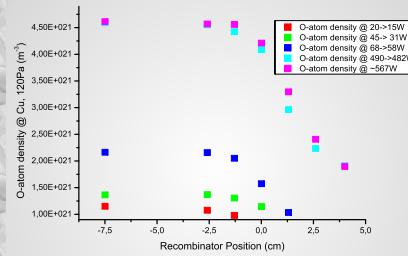


Figure 4: Neutral oxygen atom density at the pressure of 120 Pa using 5 different RF generator powers and at 5 different copper recombinator positions.

Liquid Crystal Elastomers, Electrocalorics, and new Soft Magnetoelectrics: Materials for Advanced Technologies

Brigita Rožič^{1,2}, Zdravko Kutnjak^{1,*}, George Cordoyiannis¹⁰, Boštjan Zalar¹, Slobodan Žumer^{1,6}, Simon Krause⁷, Heino Finkelmann⁷, Barbara Malič³, Alja Kupec³, Janez Holc³, Marija Kosec³, Raša Pirc⁴, Robert Blinc¹, Marko Jagodič^{8,10}, Sašo Gyergyek⁵, Miha Drofenik⁵, Samo Kralj⁹, Gojmir Lahajnar¹, Zvonko Jagličić⁸

¹ Condensed Matter Physics Department, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

³ Electronic Ceramics Department, ⁴ Department of Theoretical Physics, ⁵ Materials Synthesis Department, Jožef Stefan Institute, Ljubljana, Slovenia

⁶ Department of Physics, University of Ljubljana, Ljubljana, Slovenia

⁷ Institut für Makromolekulare Chemie, Freiburg, Germany

⁸ Institute of Mathematics, Physics and Mechanics, Ljubljana, Slovenia

⁹ Department of Physics, University of Maribor, Maribor, Slovenia

¹⁰ EN-FIST Centre of Excellence, Ljubljana, Slovenia

Brigita.Rozic@ijs.si; * supervisor

All our studied materials mentioned above (liquid crystal elastomers, electrocalorics and soft magnetoelectrics) are very perspective for various applications. Liquid crystal elastomers, i.e., materials with combined properties of elastomers (rubbers) and liquid crystals, are novel advanced materials exhibiting the giant thermomechanical response, which is very important for sensors, actuators, and artificial muscles of new generation. Study of the nature of I-N transition and its control will allow also control of thermomechanical response which can be tailored to specific application demand. Studies of electrocalorics, i.e., materials that exhibit a temperature change under an applied/removed electric field at adiabatic conditions, are very important for development of electrocaloric elements which will play a crucial role in novel environmentally friendly cooling/heating devices with practically no moving parts and better energy efficiency. Possible applications include refrigerators in household, heat pumps, devices for cooling computer chips, applications in microrobotics, sensors, actuators, etc. Magnetoelectrics are materials that exhibit simultaneously ferroelectric and ferromagnetic properties, and in such materials it would be possible to control the magnetic properties via electrical ones, and vice versa. These materials attract considerable scientific attention because of their widespread applications as actuators, transducers, and memory devices. Development and discovery of new magnetoelectric materials is of great importance for such applications. Our development of new soft magnetoelectrics has proved for the first time that soft materials can also exhibit magnetoelectricity, which could open new possibilities in application of magnetoelectric materials. So, magnetoelectrics are expected to revolutionize computers. Such memory element would permit an electric write operation combined with a magnetic read, eliminating the need for the destructive read in present-day ferromagnetic RAMs, thus making possible fatigue-free memories.



Liquid Crystal Elastomers, Electrocalorics, and new Soft Magnetoelectrics: Materials for Advanced Technologies

Brigita Rožič, prof. mat. (brigita.rozic@ijs.si)

Jožef Stefan International Postgraduate School, Nanosciences and Nanotechnologies

MENTOR: prof. dr. Zdravko Kutnjak

CO-AUTHORS:



- ❖ **Liquid Crystal Elastomers:** G. Cordoyiannis, B. Zalar, A. Lebar, S. Žumer and H. Finkelmann's group
- ❖ **Electrocalorics:** B. Malič, A. Kupec, J. Holc, M. Kosec, R. Pirc, R. Blinc and Q. M. Zhang's group
- ❖ **New soft Magnetoelectrics:** M. Jagodič, S. Gyergyek, M. Drofenik, S. Kralj, G. Lahajnar, Z. Jagličić

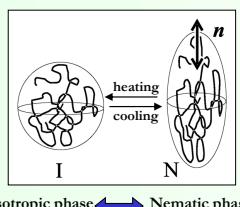


Abstract

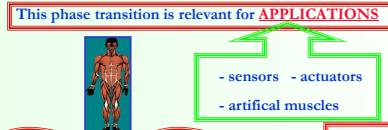
In recent years, a pronounced interest in materials that are perspective for applications in everyday life has started to grow. Our interest has been focused on different conversions of energies in such advanced materials. We have studied a giant conversion of thermal to mechanical energy, i.e., thermomechanical effect in main-chain and side-chain liquid crystal elastomers, a giant conversion of electrical to thermal energy, i.e., electrocaloric effect in PLZT thin films, and an electric control of magnetization, i.e., magnetoelectric effect, in soft multiferroics such as mixtures of SCE9 ferroelectric liquid crystal and magnetic nanoparticles.

LC Elastomers

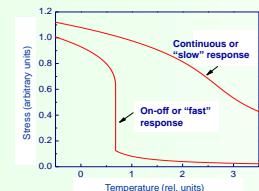
... smart materials that exhibit a giant thermomechanical effect i.e., they spontaneously stretch/shrink due to the temperature change...



Isotropic phase \xleftrightarrow{T} Nematic phase

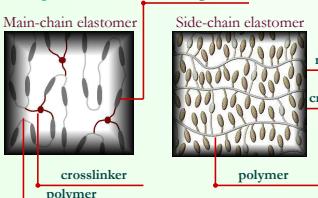


How can we control the nature of the I-N phase transition i.e., from on-off or discontinuous to continuous one?



The thermomechanical response can be tailored to specific application demand!!!

Samples:



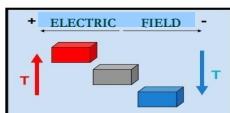
By using high-resolution calorimeter we have shown that the nature of the I-N phase transition can be controlled via three parameters:

- crosslinking concentration
- external stress field
- crosslinking temperature

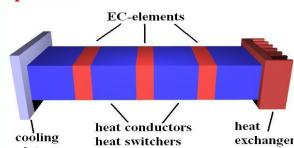


Electrocalorics

...materials that exhibit a temperature change under an applied/removed electric field at adiabatic conditions...



Schematic representation of the electrocaloric device:



Significant gradient in temperature can be achieved across such device.

APPLICATIONS

- Cooling and heating devices (refrigerators, heating pumps)
- Sensors and actuators
- Applications in microrobotics and microelectronics (cooling the electronic components)

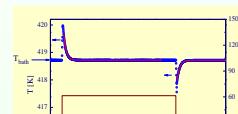


ADVANTAGES

- Simple design
- No moving parts
- More efficient
- Environmentally friendlier
- Lower cost of production
- Prestige of companies in the market



Direct electrocaloric measurements via high resolution calorimeter



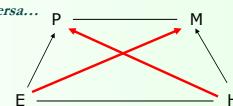
Samples:



We can conclude that direct measurements confirm existence of the giant electrocaloric effect in thin PLZT films i.e., the PLZT thin films are the best electrocalorics.

Soft Magnetoelectrics

...materials that exhibit simultaneously ferroelectric and ferromagnetic properties, and in such materials it would be possible to control the magnetic properties via electrical ones, and vice versa...



APPLICATIONS:

Example: COMPUTER

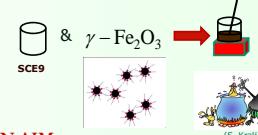
- Today: (two components) magnetic field (H): writing
- electric field (E): computation

- Tomorrow: Magnetoelectrics (one component for both operations)



Samples:

Mixture of LC and magnetic NPs



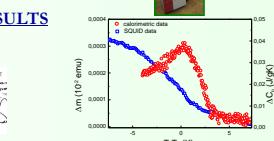
(S. Kraž)

THE MAIN AIM

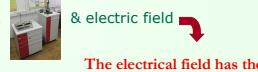
* show the coupling between the magnetic (M) and ferroelectric (P) order via the director field ...

- High resolution calorimeter
- SQUID susceptometer

RESULTS

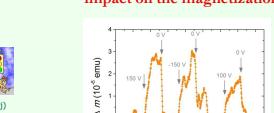


the coupling between the LC director field & the magnetization of NPs



& electric field

The electrical field has the impact on the magnetization!



Ferroelectric LC & magnetic NPs

...candidates for soft indirect magnetoelectrics

Innovative Approach to Synthesis of $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ Based Materials using Colloidal Interactions

Gregor Trefalt^{1,2}, Barbara Malič¹, Bosiljka Tadić³, Janez Holc¹, Danjela Kuščer¹, Marija Kosec¹

¹ Electronic Ceramics Department, Jožef Stefan Institute, Ljubljana, Slovenia

² Jožef Stefan International Postgraduate School, Ljubljana, Slovenia

³ Department of Theoretical Physics, Jožef Stefan Institute, Ljubljana, Slovenia

gregor.trefalt@ijs.si

PMN and PMN-PT relaxor-ferroelectric materials are widely studied because their electrical properties (e.g. dielectric permittivity, electrostriction, piezoelectricity, ferroelectricity) enable their use in capacitor, actuator and sensor applications. Some of their typical applications are in actuators for precise positioning (piezo stages), sensors for force and pressure, ultrasonic transducers (medical imaging), and energy harvesting devices. It is hard to produce good quality ceramics from these materials, due to the formation of secondary pyrochlore phases during the synthesis. This work presents a new and simple approach to the synthesis of these materials with only one calcination step. This method has a potential to lower the production costs of these materials. A further advantage of this method is the use of environmentally friendly aqueous media and simple starting materials as well as simple and efficient processing techniques. Moreover, the method presented in this work is to our knowledge a new approach in the field of solid-state chemistry of complex multi-metal oxides. We suppose that our approach of solid-state synthesis with designed heterogeneity could be used generally for the synthesis of materials with a complex chemical composition, which are of high technological importance.



MEDNARODNA
PODIPLOMSKA ŠOLA
JOŽEFA STEFANA

JOŽEF STEFAN
INTERNATIONAL
POSTGRADUATE SCHOOL



Innovative Approach to Synthesis of $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ Based Materials using Colloidal Interactions

Gregor Trefalt¹, Barbara Malič¹, Bosiljka Tadić², Janez Holc¹, Danjela Kuščer¹, Marija Kosec¹

¹ Electronic Ceramics Department, Jožef Stefan Institute, Ljubljana, Slovenia

² Department of Theoretical Physics, Jožef Stefan Institute, Ljubljana, Slovenia

e-mail: gregor.trefalt@ijs.si

student: Gregor Trefalt, school: Jožef Stefan International Postgraduate School, programme: Nanoscience and Nanotechnologies, mentor: Prof. Dr. Marija Kosec

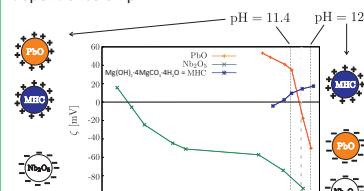
Scientific Part

Problem

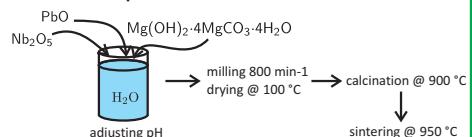
- in the conventional solid-state synthesis of perovskite $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ (PMN) based compounds lead and niobium oxide preferentially react to the **pyrochlore phases**
- after the reaction in addition to the perovskite secondary **pyrochlore phases** are present in the product and they **largely deteriorate** the electrical properties of the perovskite material
- to avoid the formation of **pyrochlores** usually **two-step** solid-state **synthesis** is used

Idea

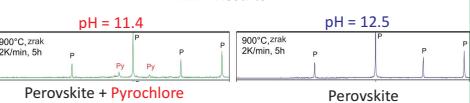
- to prepare the pyrochlore-free PMN based materials in one-step solid-state synthesis by avoiding the contacts between lead and niobium oxide particles in the reaction mixture and thus slow down the reaction to pyrochlore
- the charge of the starting material particles was measured in dependence on pH



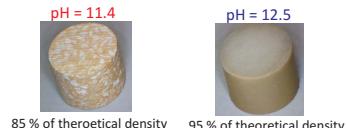
Results - Experiment



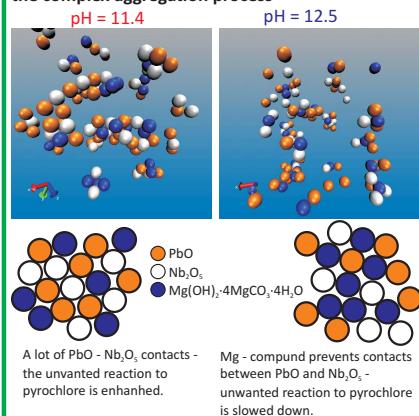
XRD Results



Samples after sintering

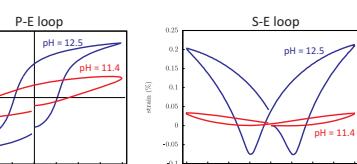


Use of simulations - to get an insight in the complex aggregation process

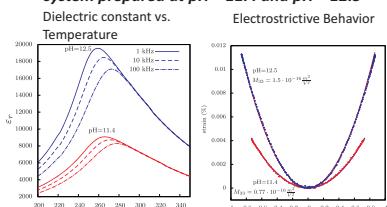


- two pH values were chosen for further investigation:
- 1. **pH = 11.4**, where PbO and Nb_2O_5 possess opposite charge and they are attracted
- 2. **pH = 12.5**, where PbO and Nb_2O_5 both possess negative charge and therefore they are repelled

Comparison of Ferroelectric and Piezoelectric properties of the 0.65PMN-0.35PT system prepared at pH = 11.4 and pH = 12.5



Comparison of Dielectric and Electrostrictive properties of the PMN system prepared at pH = 11.4 and pH = 12.5



Application of $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ Based Materials - Relaxor Ferroelectrics

$\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ (PMN), $(1-x)\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3-x\text{PbTiO}_3$ (PMN-PT)

Interesting Properties

- high dielectric constant ($\epsilon_r = 5000 @ RT$)
- high electrostriction coefficient (PMN)
- excellent piezoelectric properties (PMN-PT): ceramics $d_{33} = 700 \text{ pC/N}$, crystal $d_{33} = 2000 \text{ pC/N}$
- good ferroelectric properties (PMN-PT)

Precision movement

Piezostage for precision movements



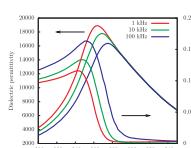
Actuators

Large displacement actuators based on PMN-PT thick films



Important for Basic Research

- PMN is a Model Relaxor System



Energy harvesting

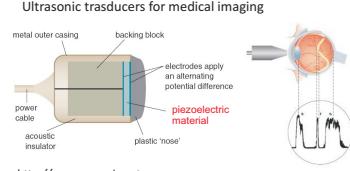
Autonomous temperature sensor based on piezoelectric harvester.



<http://www.energyharvestingjournal.com>

Ultrasonic Transducers

Ultrasonic transducers for medical imaging



Acknowledgments

- ARRS for funding (PR-02485 and P2-105)
- Sebastian Glinšek
- Silvo Dernovšek
- Jana Glinšek

Prispevki iz industrije (Contributions from industry)

Raziskovalno-razvojni program skupine Domel

Janez RIHTARŠIČ, Matjaž ČEMAŽAR, Gašper BENEDIK

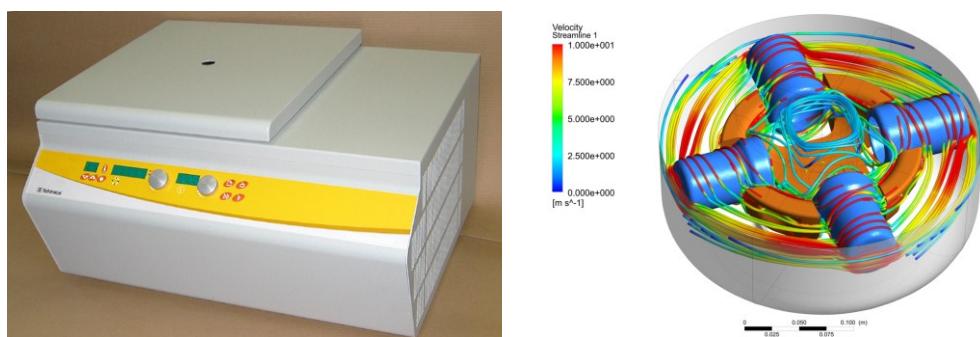
DOMEL, d.o.o., Otoki 21, 4228 Železniki

Raziskovalno – razvojni program podjetij je vezan na njihove obstoječe ali prihodnje proizvode oz. storitve. Domel ima široko paletu proizvodov od brizganih in štancanih komponent, do bolj kompleksnih mehatronskih pod-sklopov ter končnih produktov. V nadaljevanju so predstavljena produktna paleta in področja raziskav, ki podpirajo njihovo konkurenčnost ter uspešnost na globalnem trgu.

1.0 Produktna paleta in vpliv razvoja na tržno uspešnost

Večinski delež Domelove prodaje predstavljajo elektromotorji z nadgradnjami za različne aplikacije kot so:

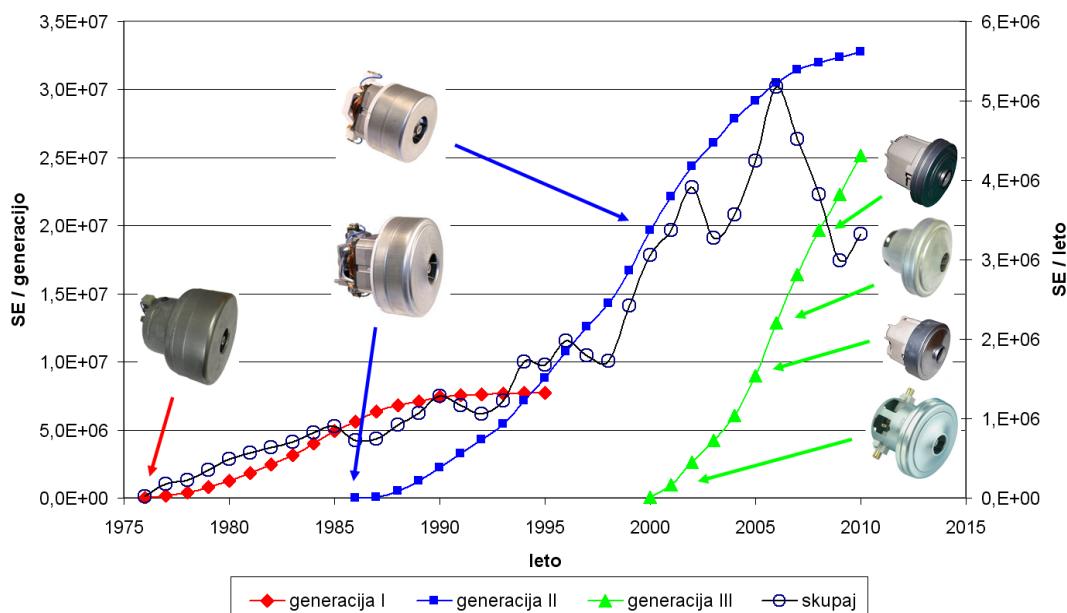
- čistilna tehnika: sesalniki za suho in mokro sesanje, ulični čistilniki
- gospodinjski aparati: palični mešalniki, kavni mlinčki
- vrtna oprema: kosilnice, motorne žage, obrezovalniki, puhala
- avtomobilска industrija: radarski sistemi, zavorni sistemi
- prezračevanje: centralni klimatski sistemi
- industrijske aplikacije: odsesovalni sistemi, predilni stroji, igralnice
- gorivne celice: dovod in regulacija delovnega medija ter zraka
- laboratorijski sistemi: centrifuge, stresalniki , mešalniki, pretočne banje, inkubatorji...



Slika 1: Laboratorijska centrifuga Centric 400 in simulacija tokovnic zraka okoli rotirajočih kivet [1].

Skupno vsem omenjenim programom je pretok oz. pretvarjanje energije. Za rast in ohranjanje tržnega deleža pa je potrebno izdelke neprestano izpopolnjevati. Vpliv izpopolnjevanja izdelka na njegovo življenjsko dobo in uspešnost na trgu predstavlja slika 2 [2]. Tu je kot primer velikoserijskega izdelka predstavljena 35-letna zgodovina razvoja sesalnih enot podjetja Domel, d.o.o., ki se večinoma vgrajujejo v sesalne aparate za suho sesanje. Generacije sesalnih enot se med seboj ločijo po večjih spremembah, ki omogočajo preskok v izboljšanju funkcionalnosti izdelka. Na spremembo funkcionalnosti vplivajo tudi trendi trga; tako je bil v devedesetih letih prejšnjega stoletja poudarek na visokih električnih močeh, ki pa se konec prvega desetletja tega stoletja obrača v smeri večje ekološke osveščenosti.

Življenjski cikel posamezne generacije se zaključuje, ko postaja krivulja vseh prodanih enot posamezne generacije horizontalna. Preden zaidemo v to področje, je potrebno na tržišče lansirati novo generacijo izdelkov, vendar moramo tudi za ohranjanje in rast trga znatnaj posamezne generacije neprestano izpopolnjevati produkt. Povezavo med izpopolnjevanjem izdelkov in rastjo trga dobimo, ko združimo grafe življenjskih ciklov izdelkov ter prodajo. Graf vseh prodanih enot v posameznem letu nakazuje lokalna nihanja trga, vendar je iz večletnega trenda opazna povezava med rastjo trga in razvojem novih generacij produktov. Večji upad v letih 2007-2009 je poleg povečane nizko-cenovne konkurence z daljnega vzhoda tudi posledica katastrofalnih poplav, ki so prizadele proizvodno lokacijo v Železnikih v letu 2007 in globalne recesije v letih 2008 ter 2009.



Slika 2. Prehodi med posameznimi generacijami družin suhih sesalnih enot družbe Domel, d.o.o. v letih od 1976 do 2010. Barvni grafi prikazujejo število vseh prodanih sesalnih enot posamezne generacije do določenega leta, medtem ko črni graf prikazuje skupno prodajo suhih sesalnih enot v določenem letu (Skupaj je bilo do leta 2010 prodanih preko 65 milijonov suhih sesalnih enot) [2].

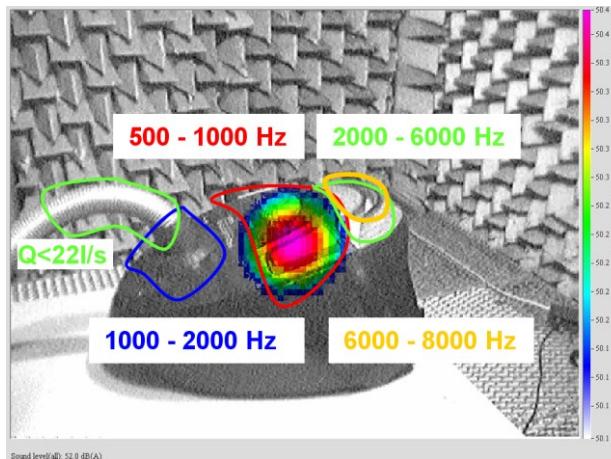
V okviru obstoječe arhitekture izdelka se spremembe najpogosteje nanašajo na spremembe dimenzijs, oblike, materiala in topologije [3]. Pri novih generacijah izdelkov se, v želji po čim manj vgrajenega materiala, povečuje tudi energijske obremenitve na količino vgrajenega materiala. Bolj radikalna spremembra delovnega principa je manj pogosta in zahteva večje finančne ter človeške vire. Poleg samega razvoja izdelkov ima predvsem pri velikoserijskih izdelkih močan vpliv na tržno uspešnost tudi tehnologija, ki mora zagotavljati njihovo kakovostno izdelavo.

Omenjenim razvojnim trendom v Domelu sledimo z optimiranjem mehanskih, elektromagnetnih, aerodinamskih, temperaturnih in akustičnih lastnosti produktov.

2.0 Razvojno - raziskovalne usmeritve

Za vodilna podjetja na trgu raznovrstna preizkušanja in benchmarking produktov ne zadoščajo. So sicer nepogrešljiva pri osvajanju in optimizaciji obstoječih tržnih produktov, vendar pa le poglobljeno vedenje o samih fizikalnih učinkih, ki potekajo pri izdelavi in

delovanju produkta, omogoča hitrejše ter uspešnejše doseganje performans najboljših izdelkov. Tako kot sam razvoj produktov pa je pomembna tudi razvojna podpora kupcev pri integraciji naših produktov v njihove sisteme (slika 3).



Slika 3. Frekvenčna analiza zvočnih virov na površini sesalnika za suho sesanje pri različnih obratovalnih režimih z uporabo akustične kamere.

2.1 Raziskovalna področja

Ker produktna paleta izdelkov Domela zahteva obvladovanje fizikalnih pojavov z različnih področij fizike, so tudi raziskovalne usmeritve raznovrstne. Trenutne bazične raziskave podjetja Domel zajemajo sledeča področja:

- mehanika
- elektromagnetika
- elektronika
- aerodinamika
- topota
- akustika

Na področju mehanike izvajamo statične (trdnostne) kot tudi dinamične analize. V sklopu dinamičnih analiz so raziskave usmerjene predvsem na rotodinamiko, lastne frekvence komponent ter sklopov in prenos vibracij ter njihovo dušenje.

Za doseganje največjih izkoristkov električnih motorjev se poslužujemo elektromagnetičnih simulacij v kombinaciji z genetskimi algoritmi za avtomatsko optimiranje geometrije motorja. Pri elektronsko krmiljenih motorjih pa je za doseganje največjih izkoristkov potrebna tudi ustrezna elektronika. Poleg izkoristka je pozornost potrebno nameniti zniževanju in odpravljanju elektro-magnetičnih motenj, ki jih električni stroji ter naprave oddajajo v električno omrežje ter prostor.

Pretvorba mehanske energije z gredi električnih motorjev v zračno energijo poteka preko ventilatorjev, puhal in kompresorjev. Tu še poseben izziv predstavlja nestabilna, turbulentna področja kot so »stall« in »surge«. Gibanje fluidov ima velik vpliv tudi na prenos oz. odvajanje topote. Dober odvod topote s konvekcijo ali prisilnim hlajenjem ter preko strukture odločilno vpliva na življensko dobo in performanse številnih mehanskih kot tudi elektronskih komponent. Zvok, ki se od produkta širi v okolico, največkrat ne vpliva na primarno funkcijo aplikacije, vendar je odločilnega pomena pri celostnem vrednotenju kvalitete izdelka. Tako je vse več aplikacij, ko ni več zadosti samo nivo zvočnega vira, ampak tudi njegova všečnost.

Na omenjenih raziskovalnih področjih tesno sodelujemo z razvojnimi centri kupcev naših produktov. Raziskovalna področja dopolnjujemo tudi z zunanjimi inštitucijami znanja.

Z Inštitutom Jožef Stefan intenzivno sodelujemo na področju vodikovih tehnologij in gorivnih celic. V okviru Razvojnega centra za vodikove tehnologije sodelujemo s podjetji Inea d.o.o., Petrol d.d., TPJ d.o.o., Mebius d.o.o. ter s Kemijskim inštitutom in Fakulteto za strojništvo UL [4]. Slika 4 prikazuje tri uspešno izvedene projekte, katerih naročnik je Ministrstvo za obrambo Republike Slovenije: lahko vojaško vozilo za posebne namene s 7 kW pomožnim napajalnim sistemom na gorivne celice (levo), mobilna kogeneracijska enota z napajanjem na gorivne celice (sredina) ter mobilni testni laboratorij za testiranje vodikovih tehnologij (desno). Poleg tega sodelujemo na projektih Centra odličnosti nizkoogljične tehnologije ter na več mednarodnih konzorcijskih projektih z vodilnimi podjetji s področja vodikovih tehnologij kot so Hydrogenics (Kanada), Electro Power Systems (Italija), HyGear (Nizozemska), Rampini (Italija), Vallant (Nemčija) in drugi.



Slika 4. Rezultati treh projektov z aplikacijo gorivnih celic za Ministrstvo za obrambo Republike Slovenije [5,6].

Domel je svetovno priznani razvojni dobavitelj sistemov za dovod zraka v sistemih z gorivnimi celicami gnanih z elektronsko komutiranim puhalom. Spin-off podjetja Domel Energija d.o.o. deluje kot predstavnik, distributer, svetovalec ter sistemski integrator sistemov z gorivnimi celicami.

2.2 Raziskovalna oprema

Za uspešne analize in simulacije fizikalnih pojavov je potrebno zagotoviti natančne vhodne podatke. V proizvodnih podjetjih običajno prvo raziskovalno opremo predstavlja oprema za kontrolo kakovosti produktov. Kontrolne meritve naprave so pogosto strogo namenske in v večini primerov ne zagotavljajo podatkov o obratovanjih pri »nevsakdanjih« pogojih, kot so nepredvideni primeri uporabe, preobremenitve ali ekstremne razmere v okolini. Za preučevanje delovanja produkta v takšnih razmerah se v Domelu poslužujemo raziskovalne opreme kot so stresalnik, klimatske komore, termična in akustična kamera, gluha soba, ter specifična testna oprema za izvedbo kratkotrajnih ali dolgotrajnih obremenitvenih testov.

Raziskovalna oprema je potrebna tudi za samo verifikacijo, najprej prototipov ter kasneje končnega produkta. Zato raziskovalno opremo vsakoletno nadgrajujemo, v posameznih primerih pa se poslužujemo storitev zunanjih raziskovalnih partnerjev.



Slika 5. Testiranje EC motorja za prezračevalne sisteme v klimatski komori pri -40°C.

3.0 Sklep

Raziskave in razvoj izdelkov so nujno potrebne, da si proizvodno podjetje zagotovi delež ter obstoj na globalnem trgu. Raziskovalno-razvojna usmeritev skupine Domel temelji na potrebah sedanje in napovedih prihodnje produktne palete. Obstoeča raziskovalna področja, ki zajemajo mehaniko, elektro-magnetiko, elektroniko, aerodinamiko, akustiko ter toploto, se bodo v bodoče nadgrajevala in dopolnjevala z drugimi področji, kot npr. kemija. Raziskave zahtevajo tudi vlaganja v raziskovalno opremo in zlasti kadre. Zato v skupini Domel vsakoletno razpišemo štipendije za tehnične, dodiplomske in podiplomske programe. Izpopolnjevanje se nadaljuje tudi na strokovnih seminarjih in v sodelovanju na državnih in mednarodnih raziskovalnih razpisih.

Uspešnost takšnega pristopa pri razvoju izdelkov se kaže tudi v vsakoletnih priznanjih za inovativnost, ki jih Domel dobiva od Gospodarske zbornice, predvsem pa v priznanjih, ki jih izkazujejo poslovni partnerji skozi dolgoletno sodelovanje.

Viri in literatura:

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EMO Orodjarna

Celje, Slovenija

EMO Orodjarna spada med največje slovenske orodjarne, še posebej, kadar govorimo o konstrukciji in proizvodnji orodij za obdelavo in preoblikovanje pločevine. EMO orodjarna sodeluje z največjimi svetovnimi proizvajalci avtomobilov in dobavitelji za avtomobilsko industrijo. Podjetje nudi svojim kupcem kompletne rešitve, od konstrukcije do proizvodnje, celoten proces pa omogočata uporaba visoke tehnologije in strokovni kader.

Ena od komponent v tem procesu je tudi Catia - programska oprema za načrtovanje vrhunske kakovosti proizvodov. V EMO Orodjarni smo začeli z enim delovnim mestom verzije 4 in si tako zagotovili kompatibilnost in kvalitetno izmenjavo podatkov z večino poslovnih partnerjev, ki so standardizirani na Catia CAD/CAM programskem paketu. Ko smo se prepričali, da lahko brez težav komuniciramo s partnerji tudi ob izključni uporabi verzije 5, smo se v EMO Orodjarni odločili za migracijo na Catio V5.

FRAKTALNA DIMENZIJA PRI ROBOTSKO LASERSKO KALJENIH VZORCIH STANDARDNE OZNAKE PO DIN STANDARDU 1.7225

M. Babič, P. Kokol, M. Milfeler, B. Kužnik, M. Kosec, S. Babič

ABSTRACT

Robotsko lasersko kaljenje je površinska topotoma obdelava komplementarnih s konvencionalnimi plamenškim ali induktivnim kaljenjem. Vir energije pri laserskem kaljenju je laserski žarek, ki izredno hitro segeje površino kovine ter kali površino do 1,5 mm in tido do 65 HRe. Lasersko kaljenje je proces z izstopajočimi lastnostmi kot so brez določilne medede, kontroliran vnos energije, visoka zmogljivost, konstantnost procesa in točno pozicjoniranje. Trda martenitna mikrostruktura zagotavlja izboljšane lastnosti površine, kot je odpornost na obrabo in visoka trdnost. Lasersko kaljenje ima kar precej prednosti. Te so:

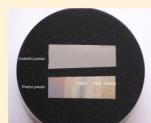
- manjši stroški obdelave,
- ni potrebe po kljenjanju,
- visoka fleksibilnost,
- možnost avtomatizacije v proizvodni proces,
- izjemna obrabna obstojnost kaljene površine,
- kaljenje komplificiranih geometrijskih oblik
- točkovno kaljenje,
- ni lokalnega taljenja materiala,
- zelo majhne deformacije materiala,
- visoka natančnost in prilagodljivost,
- običajno ni dimenzijskih odstopanj,
- ni sprememb hrapavosti površine (Ra in Rz),
- enakomerna tredota po celotni površini kaljenja,
- uporaba za vsi kaljive materiale,
- kaljenje različnih 3D geometrijskih oblik,
- spremanje in reguliranje temperature kaljenja,
- ni potrebe po 3D CAD risbah.



Slika 1: Robotsko lasersko celico za kaljenje

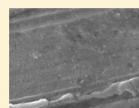
EKSPERIMENTALNO DELO

Napravili smo vzorce na orodnem jeklu standardne ozanke po DIN standardu 1.7225. Kemija sestava materiala vsebuje 0,38-0,45 C%, max 0,4 Si%, 0,6-0,9 Mn%, max 0,025 P%, max 0,035 S% in 0,15-0,3 Mo %. Orodno jeklo smo lasersko kalili z različno hitrostjo in radično močjo. Torej smo spremenjeni dva parametra hitrost $v \in [2, 5] \text{ mm/s}$ s korakom 1 mm/s in temperaturo $T \in [1000, 1400]^\circ \text{C}$ s korakom 50°C . Pri vseh teh poizkušnjah smo naredili posnetke mikrostrukture. Naredili smo posnetke površinsko kaljenega območja kakor tudi posnetke globinsko kaljenega območja. Zanimala nas je ali lahko pri robotskem laserskem kaljenju pri različnih parametrib kaljenja najdemo fraktalno strukturo mikrodelecev. Prav takos nas je zanimalo ali najdemo fraktalno strukturo pri najbolj optimalnih parametrib kaljenja. Slika 1 prikazuje vdolžni in prečni prelez kaljenega orodnega jekla.



Slika 1: Prečni in vdolžni prelez kaljenega vzorca standardne ozanke po DIN standqrdu 1.7225

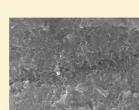
Vsak vzorec smo jedkali in polirali, šele potem smo ga opazovali pod mikroskopom. Najprej smo naredili posnetke z optičnim mikroskopom nato pa še z elektronskim mikroskopom. Slike smo naredili z field emission scanning electron microscope JSM-7600F podjetja JEOL. Na slikah 2, 3, 4 in 5 pa so prikazane mikrostrukture kaljenega orodnega jekla pri različnih povečavah.



Slika 2: 10000 kratna povečava



Slika 3: 20000 kratna povečava



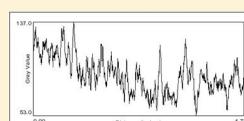
Slika 4: 40000 kratna povečava



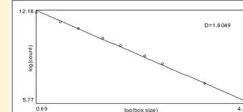
Slika 5: 80000 kratna povečava

REZULTATI

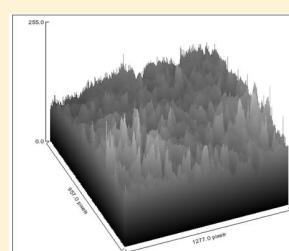
Slike formata (e.g., .jpeg) smo konvertirali v 256 grey level numerical matrices (level 1 for black and 256 for white) z programom ImageJ in naredili dvodimensionalni graf, kjer smo uporabili R/S rescaled range analysis metodo. V vsaki točki (x,y) slike (2D ravnila) določimo vrednost od 1 do 256. Ta vrednost nam določa tretjo koordinato v 3D koordinatenem sistemu oz x-z koordinato. To pomeni, da točka $T=(x,y)$ z ravnila dobri tretjo komponento z in ima poten obliko $T_{3D}=(x,y,z)$. Graf 1 in Graf 2 prikazujejo primer RGB analize za kaljene vzorce pri določenih parametrib.



Graf 1: RGB Graf na površini



Graf 2: log-log graf za Graf 1



Graf 3: 3D graf za Graf 1

ZAKLJUČEK

Robotsko lasersko kaljenje je uporabno v avtomobilski in vojaški industriji. Vendar pa lahko tudi pri robotskem laserskem kaljenju opazimo zelo različne zanimivosti. Ena je pravfraktalna geometrija.

Fraktale lahko opazimo v naravi, pri človeku, v tehnologiji in kar je zanimivo tudi pri strukturah na različnih kaljenih materialih.

Zanimivo je tudi pogledati kako je fraktalna struktura robotsko lasersko kaljenega orodnega jekla odvisna od tredote.

DEFINICIJA

Fraktalna dimenzija je lastnost frakta, ki se ohranja prek vseh povečav in je zato dobro definirana, poleg tega nam pa tudi pove, kako kompleksen je fraktal. Fraktalno dimenzijo izračunamo po formuli

$$M_D(E) = \liminf_{\delta \rightarrow 0} \sum_i r_i^D$$

Kjer so x_1, x_2, \dots, x_k radiji krogel (krožnic) s katerimi pokrivamo množico E , M_D je mera množice v D dimenzijah in je ekvivalentna dolžini pri $D=1$, ploskini pri $D=2$ itn.

Fraktalne dimenzije se v splošnem ne da računati po zgornj navedenem postopku, saj je to mogoče le na čistih matematičnih konstruktih, ki pa jih v naravi ni. Kljub veliki natančnosti je zgornja definicija za fiziko bolj ali manj neuporabna, saj je ne more biti poljubno natančna, pa tudi fraktele opazimo samo z določenem velikostnem območju. V praktični namenitosti za določanje dimenzije največ uporablja metodo "stejet skale" (box-counting dimension), kjer preučevani fraktal pokrijeemo s kvadratno mrežo, ki jo nato vse bolj manjšamo in opazujemo spremembo števila kvadratov, potrebnih, da pokrijemo celotno množico. Rezultat je vedno približek, ki ga izračunamo na želeno število mest.

Matematična definicija

Fraktal je skupek točk, kateri je fraktalna dimenzija večja od topološke dimenzije.

Fraktalna analiza je uporabna ravno takrat, ko nam klasična geometrija ne da dovolj uporabnih rezultativ za opis irregularnih objektov. Fundamentalna lastnost frakta je fraktalna dimenzija D , ki da pomemben pogled na fizikalne lastnosti različnih materialov.

Fraktalna značilnost so opazili tudi pri računalniško mehanički simulaciji, katero je mogoče razložiti s fraktalom Gauss-Markovega naključnega polja.



Slika 3: Fraktalna mikrostruktura lasersko kaljenega orodnega jekla

NADALJNO DELO

V nadalje želimo izračunati fraktalno dimenzijo pri različnih kaljenih materialov in sicer pri:

- dvo-žarkovnem robotsko laserskem kaljenju,
- conah prekrivanju,
- točkovnem kaljenju,
- točkovnem kaljenju na različnih višinah,
- različnih parametrib robotske laserske celice za kaljenje,
- za različne povečave in jih med seboj primerjati.

TRAJNOSTNI RAZVOJNO RAZISKOVALNI PROGRAMI PRI PROIZVODNJI ALUMINIJA IN ALUMINIJEVIH PROIZVODOV

TALUM d.d., Tovarniška 10, 2325 Kidričevo
Marko Homšak, Albert Korošec, Boštjan Korošec

Družba Talum je edini proizvajalec primarnega aluminija in aluminijevih proizvodov v Sloveniji. Za nami je več kot polstoletna tradicija, najprej s proizvodnjo glinice in primarnega aluminija, ki se je začela v tedanji Tovarni glinice in aluminija (TGA) leta 1954.

Aluminij je kovina prihodnosti, ne rjavi, zato ohranja trajnost in daje zanesljivost predmetom. Aluminij je ponovljiv in enak, ne glede na to, kje in kdo ga proizvaja ter na kakšnih napravah. Njegova lahkotnost pa je še bolj prepričljiva, če je proizведен brez večjih vplivov na okolje, kar dokazujemo s stalnim zmanjševanjem "ekološke stopinje". Morda je naključje, vendar ni težko ugotoviti, da je od začetka proizvodnje aluminija v Kidričevem vsak proizvedeni milijon ton aluminija tovarno zaznamoval z drugačno podobo. Pomembno pa je, da postajajo ta obdobja vedno krajša, da odražajo rezultate zastavljenih razvojnih ciljev, da je podoba tovarne lepša in da je njeno sporočilo preprosto prepoznavno: *Lahkota prihodnosti*.

Nova podoba Taluma je takšna, da tudi brez razlage in podatkov pojasnjuje in odpravlja ponekod še vedno prisotne zmotne predstave o tej tovarni. V okviru njene tehnološke prenove so bili zgrajeni sodobni objekti in vgrajene sodobne naprave po principu najboljših razpoložljivih tehnik, kar je v skladu z evropsko direktivo IPPC; te tehnike pomenijo bistven napredok tako z vidika produktivnosti, porabe energije in surovin kot z vidika varovanja okolja oziroma možnih emisij v okolje.

Smo v času, ko evropske in svetovne spremembe – poslovne, okoljske in socialne – na področju aluminijске industrije predstavljajo za z novim letom reorganizirano družbo Talum nove izzive.

Trajnostno naravnani razvojno-raziskovalni program je vpet v vizijo razvoja družbe, in sicer:

- ohraniti aluminijsko industrijo v Kidričevem in proizvajati aluminij ter proizvode iz aluminija skladno z okoljsko zakonodajo;
- povečevati obseg proizvodnje s pretaljevanjem sekundarnega aluminija, ob hkratnem zmanjševanju porabe primarne energije;
- nadgrajevati proizvodni program predelave z litjem različnih polproizvodov ter njihovo obdelavo do končnih proizvodov in s tem povečevati dodano vrednost;
- ohranjati visoko kakovost proizvodov in že osvojene domače in EU-trge ter si zagotoviti še nove;
- povečati obseg raziskav in vlaganj v izgradnjo tehnologij za proizvodnjo energije iz obnovljivih virov ter izrabe »odpadne« energije iz tehnoloških procesov, z namenom zmanjšanja rabe primarne energije;
- ohranjati vse poslovne funkcije in obstoječo raven zaposlenih s krepitvijo znanja, inovativnosti in povezovanja med različnimi gospodarskimi in razvojno-raziskovalnimi inštitucijami na nacionalni kot mednarodni ravni;
- krepiti učinkovitost, uspešnost in konkurenčnost;
- industrijska cona z bogato in specifično infrastrukturo je idealna osnova za nadaljnji razvoj industrije na tem območju in razvoj drugih, z aluminijem posredno povezanih ali nepovezanih dejavnosti;
- stalna rast vlaganj v raziskave in razvoj ter povezovanje partnerskih podjetij in institucij preko projektov razvoja visokih tehnologij.

Nekaj temeljnih usmeritev, ki bi lahko spodbudile razvojno-raziskovalni potencial mladih raziskovalcev, je prikazanih na vzporedni predstavitvi, kar lahko strnemo v:

1. aluminij in tehnologije, ki so povezane z njegovim pridobivanjem, recikliranjem, obdelavo in predelavo v skladu z zakonodajo s področja okolja in varnosti;
2. aluminij in proizvode iz aluminija in najrazličnejših aluminijskih zlitin, ki so pripravljeni iz vedno večjega deleža sekundarnega in odpadnega aluminija, ter drugi izdelki iz aluminija v različnih oblikah, ki šele vstopajo na tržišča, in
3. aluminij za uporabo v različnih segmentih družbe, povezan z obnovljivimi viri energije, v topotni tehniki, transportu in gradbeništvu ter različnih specifičnih aplikacijah.

Na področju tehnologij je področje recikliranja aluminija prednostna razvojna naloga, ki bo

omogočila povečevanje deleža sekundarnega aluminija v proizvodih, kar pomeni le 5 % energetskega vložka v primerjavi s proizvodnjo primarnega aluminija v elektrolizah, ob hkratnem reševanju logističnih problemov. Pridobivanje, recikliranje, obdelava in predelava aluminija so povezani z uporabo najboljših razpoložljivih tehnik na področju zmanjševanja emisij prahu in celotnih organskih snovi (TOC) ter še posebej emisij toplogrednih plinov, tj. ekvivalentov CO₂. Nov tehnološki preskok k zmanjševanju CO₂ pri pridobivanju aluminija bi pomenila t. i. inertna anoda. Za obvladovanje vedno kompleksnejših poslovnih in procesnih struktur brez sodobnih informacijsko-komunikacijskih tehnologij prav tako ne bo šlo.



Primarni in sekundarni ter odpadni aluminij, združen v skupnem pretaljevanju

Razvojno-raziskovalno polje za nove proizvode iz aluminija, ki so lahko različni po sestavi, obliki in namembnosti, je veliko in na voljo za raziskave. Proizvodi vsebujejo vedno več recikliranega aluminija, kar nakazuje na nove zlitinske programe, kar pa je usmerjeno v preiskave novih fizikalnih lastnosti proizvodov za embalažo, toplotno tehniko, letalsko in avtomobilsko industrijo ter gradbeništvo.

Kot primer vzporednih dejavnosti je družba Talum leta 2010 na območju nekdanjega odlagališča odpadkov zgradila daleč največji park fotovoltaičnih elektrarn v Sloveniji, tovrstne aktivnosti pa želi še nadgraditi z novimi elektrarnami tako na tleh kakor tudi na strehah objektov v Talumu in zunaj njega. V prihodnje bomo raziskali možnosti vgradnje in priključitve na omrežje tudi takšnih fotovoltaičnih panelov, ki so trenutno še v fazi razvoja in ki kažejo potenciale za pretvorbo sončne svetlobe v električno energijo s povečanim izkoristkom in ki za proizvodnjo ne potrebujejo direktne sončne osvetlitve. Takšne fotovoltaične elektrarne bodo manj občutljive na osončenje in bodo lahko v omrežje dalj časa oddajale večje količine električne energije, s čimer se bo delež električne energije, proizvedene iz obnovljivih virov, še povečal.

Aktivnosti izgradnje fotovoltaičnih elektrarn je družba Talum že prenesla v širši prostor

Slovenije, namerava pa jih izvajati tudi v tujini. Proizvodne enote so in bodo priključene na električno omrežje v neposredni bližini velikega odjemalca Talum, ki je zaradi specifice tehnološkega procesa v elektrolizi čisti pasovni odjemalec in ne dovoljuje izpada električne energije za čas, daljši od 1 ure. Elektrotehnično bo Talum zaradi bližine velikih sončnih elektrarn porabnik proizvedene električne energije, kar bo ugodno vplivalo na zmanjšanje izgub v prenosnem omrežju.

Družba Talum je za zagotavljanje delnih potreb po ogrevanju zgradila kotlovnico na lesno biomaso, ki jo namerava še povečati. Načrtujemo kogeneracijsko ali celo trigeneracijsko proizvodnjo energije (toplota, električna energija in hlad), s katero bi pokrili dodatne potrebe po topotni in hladilni energiji.

Načrtujemo nadaljevanje aktivnosti na področju raziskav izrabe »odpadne« toplotne, ki nastaja v tehnoloških procesih, ki je primerna tako za direktno ogrevanje prostorov in sanitarno vodo kakor tudi za nizkotemperатурne sisteme proizvodnje električne energije (sistemi ORC), ki jo bomo pošiljali v interno električno omrežje. Z izvedbo projektov izrabe »odpadne« energije načrtujemo vzpostavitev razmer za samozadostno proizvodnjo toplotne energije in s tem zmanjšanje rabe primarne energije, sedaj uporabljeni za proizvodnjo toplotne energije (zemeljski plin).



Rondelice za embaliranje (tube in doze), ulitki za avtomobilske dele, izparilne plošče za prenos toplotne v beli tehniki



Obnovljivi vir energije na zaprtem odlagališču za nove proizvode

Organizator



V sodelovanju z



Sponzorji



Seznam sodelujočih podjetij

- Akrapovič, d.d.
- BSH hišni aparati, d.o.o.
- Cosylab, d.d.
- Datalab Tehnologije, d.d.
- Domel, d.d.
- ETI Elektroelementi, d.d.
- Gorenje, d.d.
- Hyb, d.o.o.
- Juteks, d.d.
- Kolektor Group, d.o.o.
- Mediato International, d.o.o.
- Premogovnik Velenje, d.d.
- Talum, d.d.
- Telekom Slovenije, d.d.
- Trimo, d.d.
- Salonit Anhovo, d.o.o.
- Zemanta, d.o.o.

