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TiO_2 PHOTOCATALYSIS

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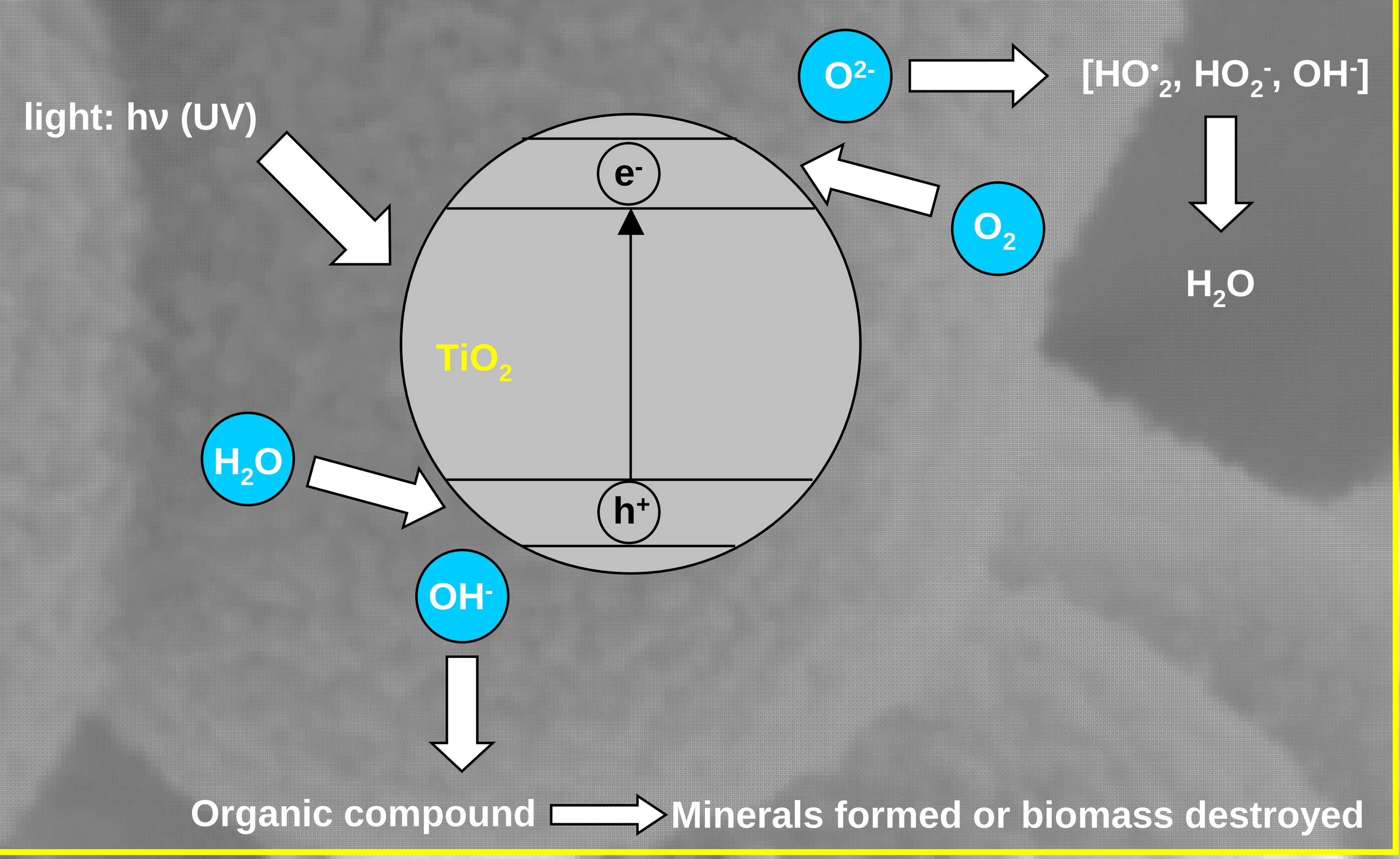
Applications of TiO_2 photocatalysis:

- disinfection of surfaces and water from pathogenic organisms (bacteria, fungi, protozoa, algae)
- removal of organic and inorganic pollutants from waste water
- air purification

Photocatalysis

Organic compound + O_2 $\xrightarrow[h\nu]{TiO_2}$ CO_2 + H_2O



Problem:

- TiO_2 absorbs mainly ultraviolet (UV) light

That is why most researches are oriented to:

- design of visible light responsive TiO_2

and

- increase of photoreactivity of TiO_2 in the near UV and visible region

Photocatalytic activity of TiO_2 depends on:

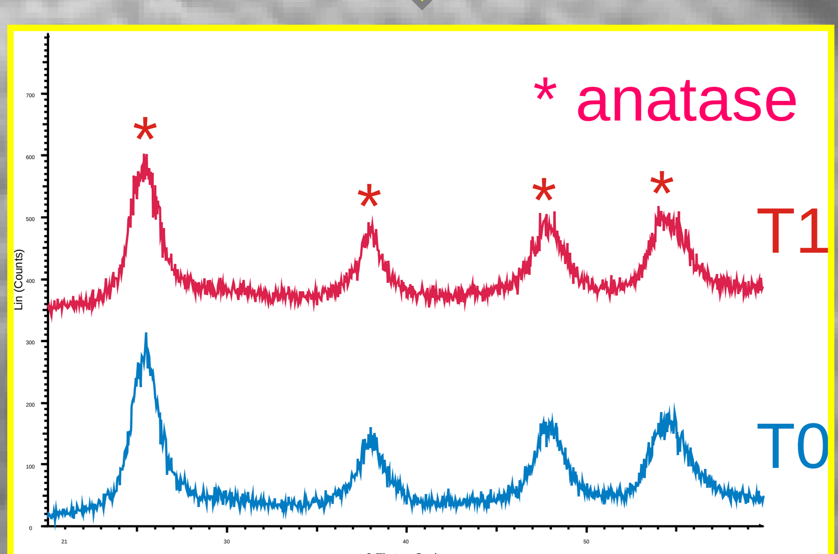
- crystal phase (anatase or a mixture of anatase and rutile)
- crystallinity
- particle size and/or specific surface area

Our research

Among the TiO_2 polymorphs (brookite, anatase, rutile) anatase is considered as the most photocatalytic active crystal phase and can be prepared by sol-gel synthesis followed by thermal treatment up to 300°C. Thermal treatment leads to particles growth and causes decrease of specific surface area. In sol gel synthesis amphiphilic copolymers can be used as templates supporting the 3D TiO_2 framework. The collapse of organic templated structure during thermal treatment can be prevent by phosphorous (P) incorporation as a TiO_2 framework stabilizer. On the other hand, high crystalline anatase with high specific surface area can be prepared by solvothermal synthesis at low temperatures.

High crystallinity

Combination of sol-gel and solvothermal synthesis
followed by thermal treatment (500°-700°C)



T0: control sample
T1: P123 + H_3PO_4

Figure 1: Crystal phases of the as prepared samples

High specific surface area and small particle size

Use of amphiphilic triblock copolymer P123 as a TiO_2 framework template
and
incorporation of P from phosphoric acid (H_3PO_4) as a TiO_2 framework stabilizer

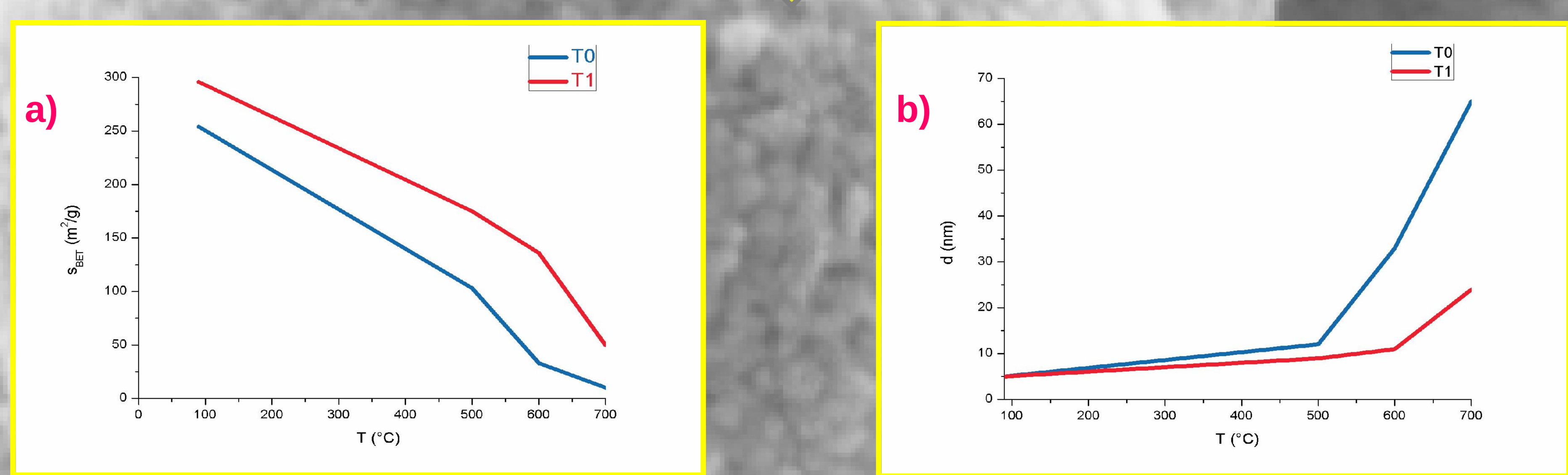


Figure 2: a) specific surface area of the as prepared samples and thermally treated samples
b) particle size of the as prepared samples and thermally treated samples

Anatase powders with high specific surface area and high crystallinity were prepared by the combination of sol-gel and solvothermal synthesis.
Using triblock copolymer P123 as a TiO_2 framework template and phosphorous as a TiO_2 framework stabilizer it is possible to synthesize anatase powders with a high specific surface area (up to 296 m^2/g) even after thermal treatment at high temperatures (at 500°C up to 176 m^2/g and at 600°C up to 136 m^2/g).