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STRUCTURE AND PROPERTIES OF INNOVATIVE SILICA HYBRID MATERIALS FOR APPLICATION IN ECOLOGY

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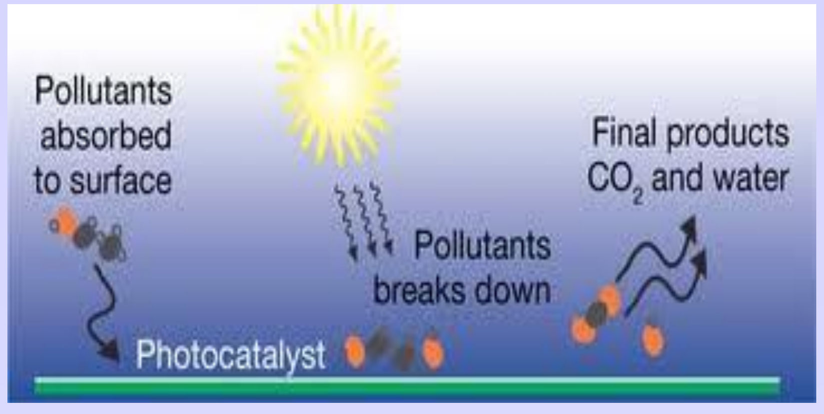
Introduction

Today ecology and environment protection are one of the main goals for people life. Development in this area requires invention of new materials, which can reduce the pollution. Hybrid materials are suitable for this purpose, because they combine different properties into one structure. Potential application of hybrid materials depends of preparation technique, nature and specific properties of initial components. One of the used method for synthesis of hybrid materials is sol-gel. This technique allows variation of component concentration and conditions (pH, temperature, pressure, humidity). Silica materials are proven as stable and compatible carriers, applicable in different fields. Incorporation of components, which can degrade pollutants into silica network lead to formation of structure with improve properties. Most used materials for degradation of different kind of pollutants are based on titanium dioxide, because of their photocatalytic activity under UV radiation. This activity is associated with formation of electrons and holes. In contact with water or air the electron/hole pairs lead to formation of hydroxyl (-OH), superoxide (O_2^-) and hydroperoxyl (-OOH) radicals. These radicals lead to degradation of organic pollutants. Combination with SiO_2 materials lead to improve degradation activity, as a result of reduce recombination of electron/hole pairs and extend photocatalytic activity. Silica hybrids, containing TiO_2 particles are applicable in environment protection. Plasticity and long-term stability of SiO_2-TiO_2 hybrids can be improve with addition of organic component. Chitosan is natural polymer, which can successfully improve microstructure and sorption activity of materials.



Main goal

Innovative silica hybrid materials, containing organic component (chitosan) and TiO_2 nanoparticles were successfully synthesized via sol-gel method. Tetraethylorthosilicate was used as silica source and network former. Titanium butoxide was used as former of TiO_2 nanoparticles with photocatalytic activity. Chitosan (CS) was used as modifier of hybrid structure. Interaction between chitosan and TiO_2 units, as well as their influence on structure of final material was investigated.

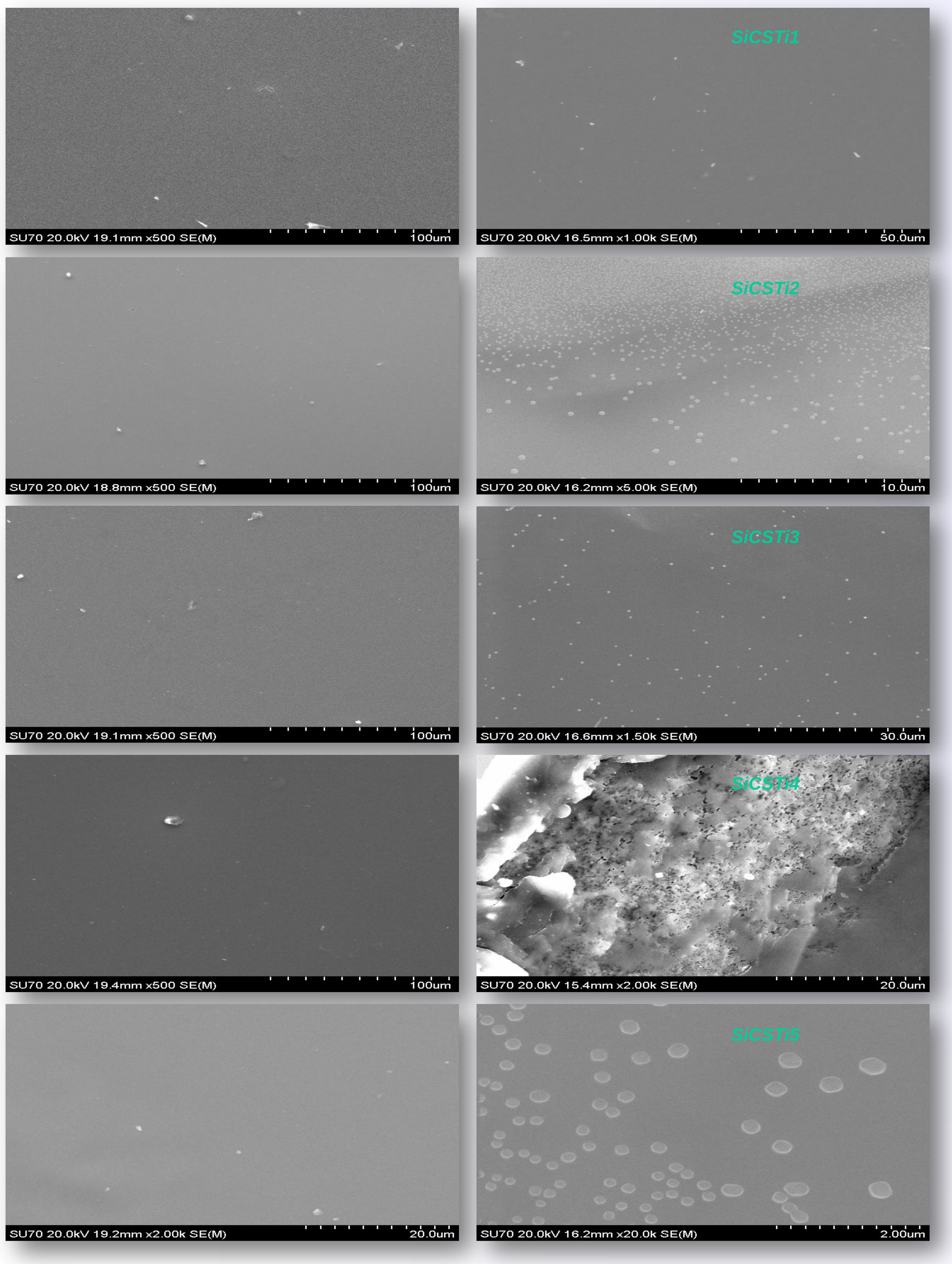


Fig. 6 SEM micrographs of surface (left) and in the volume (right) of synthesized hybrid materials

Structural characterization

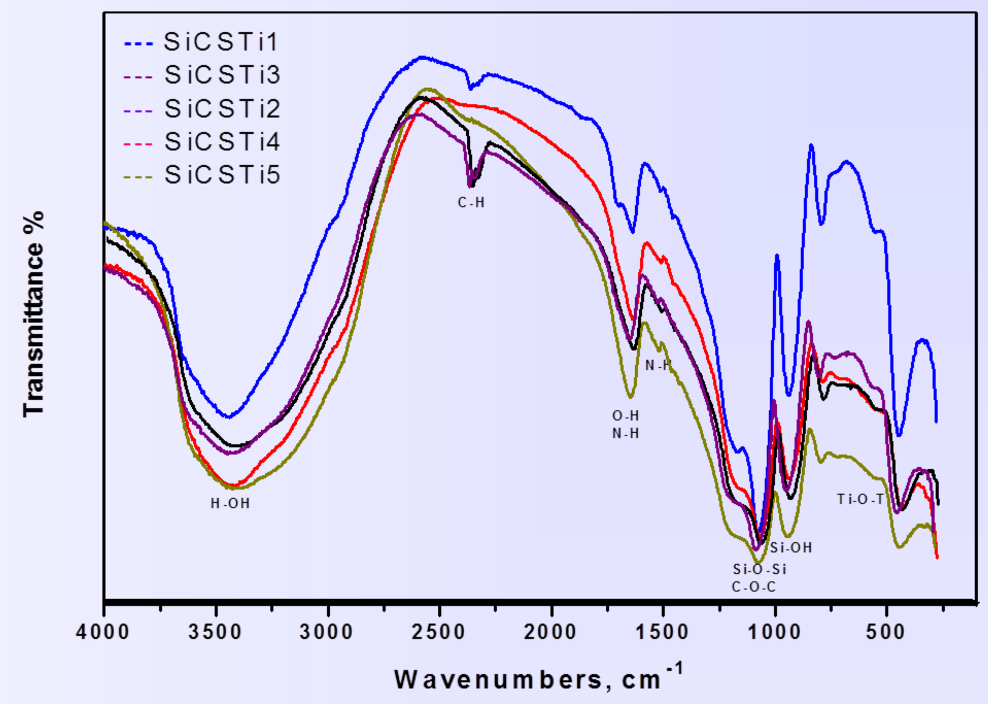


Fig. 2 FTIR spectra of synthesized Si/CS/TiO2 materials

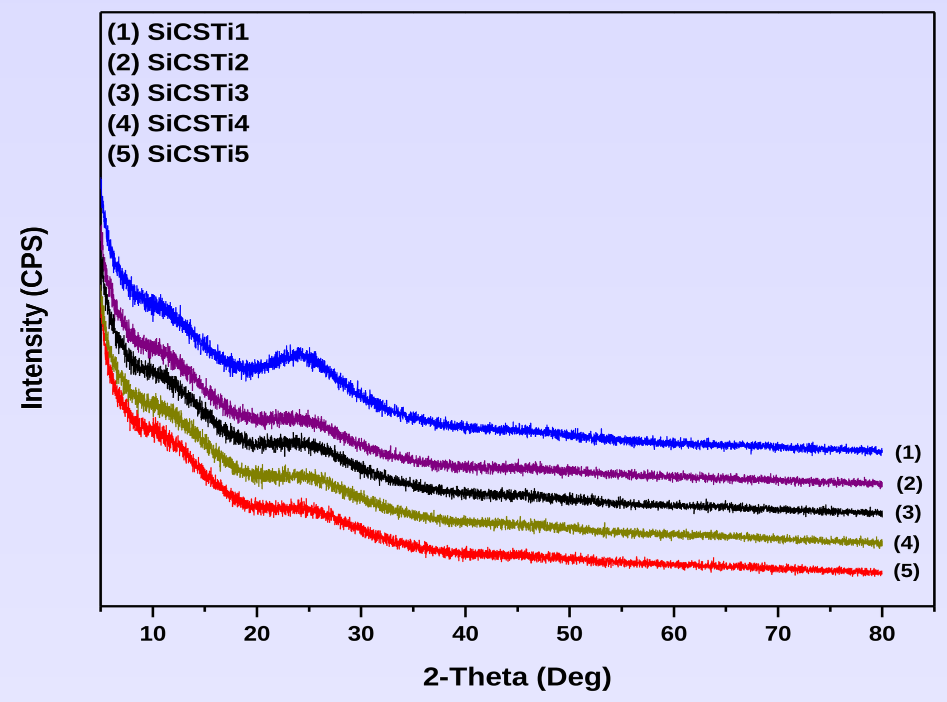


Fig.1 XRD patterns of synthesized silica hybrid materials with different quantity CS/TiO2 additives

- **Formation of amorphous structure via sol-gel technique was proven via XRD patterns;**
- **Specific bounds of silica network, as well as chitosan and TiO_2 nanoparticles were observed on FTIR spectra;**
- **FTIR spectra and NMR results established the possible interactions between used components.**
- **DTA and TG analysis presented favorable effect of chitosan and TiO_2 nanoparticles on thermal stability of final materials;**
- **Difference of weight loss between pure silica and synthesized materials is only 4%, which is prove for compatibility of initial components and formation of long-term stable hybrid structures;**
- **SEM micrographs established formation of homogeneous structures with evenly distributions of CS/TiO_2 nanoparticles (50-150 nm);**

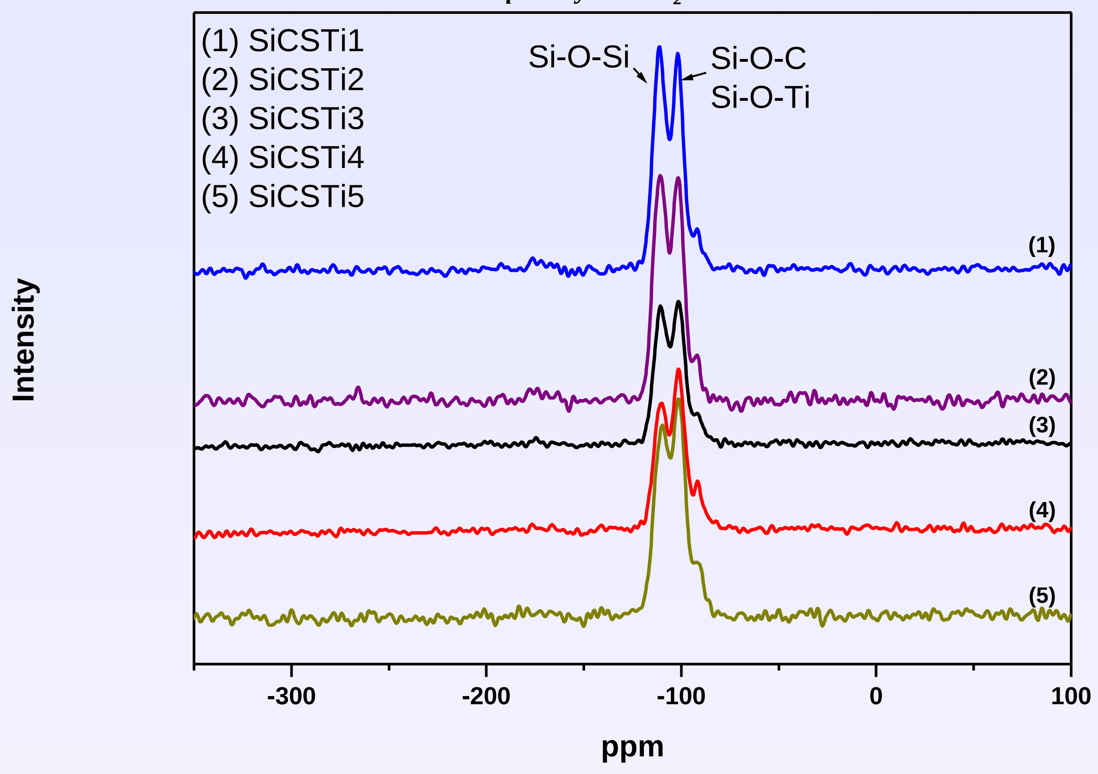


Fig. 3 [29]Si NMR of synthesized hybrid materials

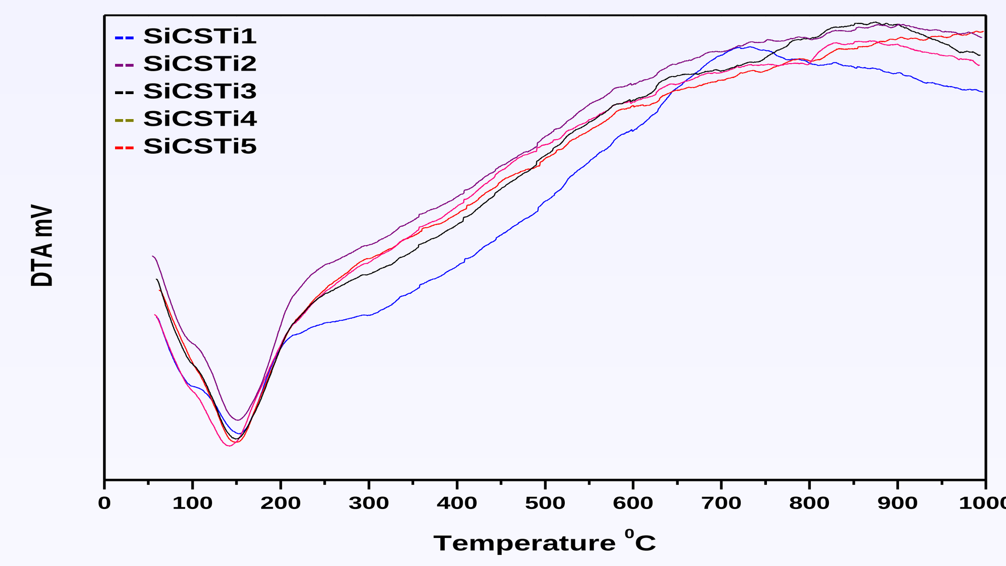


Fig. 4 DTA curves of synthesized silica hybrid materials

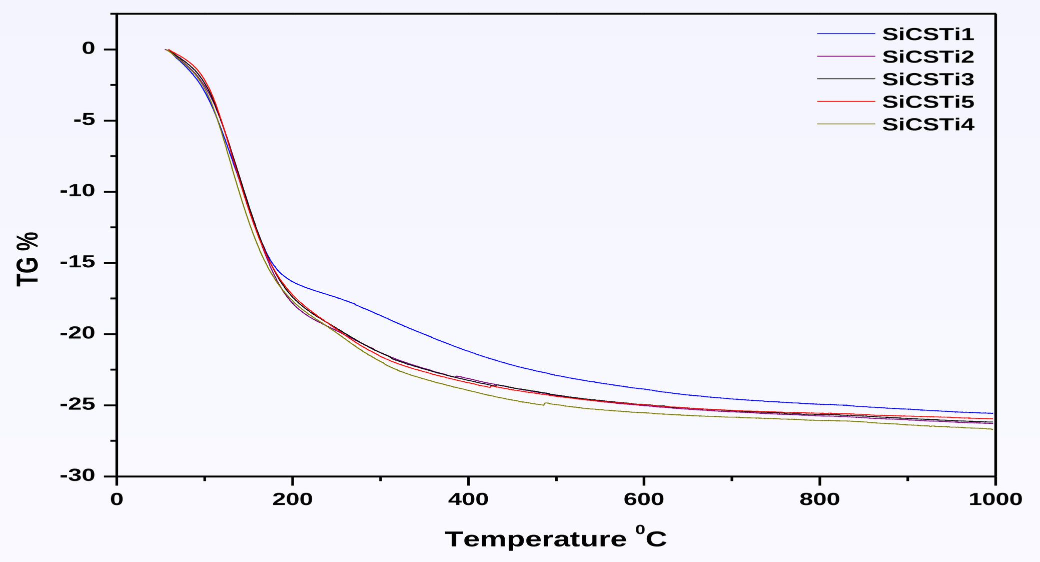
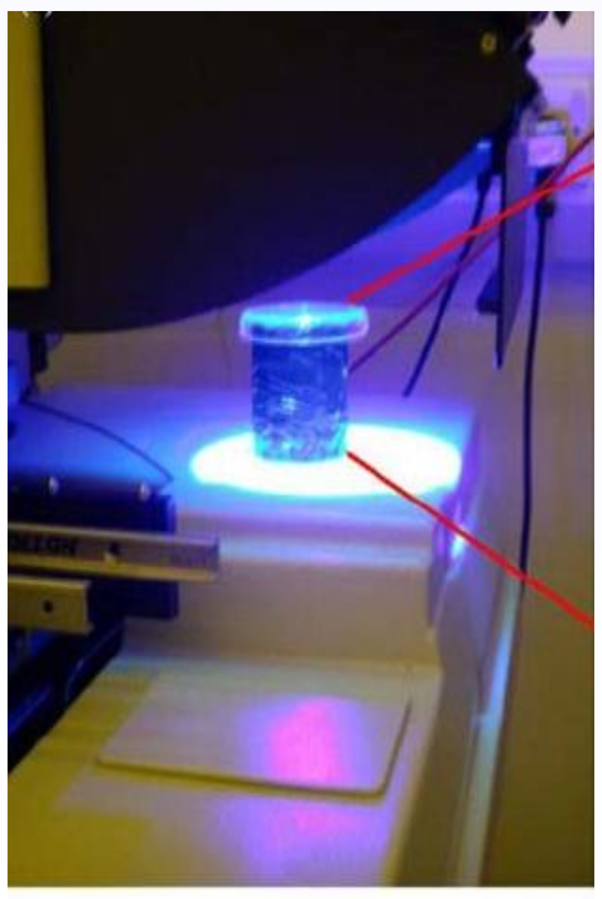


Fig. 5 TG curves of synthesized silica hybrid materials

Application

- **Photocatalytic activities of synthesized silica hybrid materials was evaluated via irradiation with UV lamp (8W);**
- **First cycle photocatalytic tests of hybrid materials using methyl orange solutions showed, that MO concentration is reduced from 80 (control) to 13,7 mg/l (SiCSTi5).**
- **Second test using the same initial concentration exhibit the same degradation activity.**



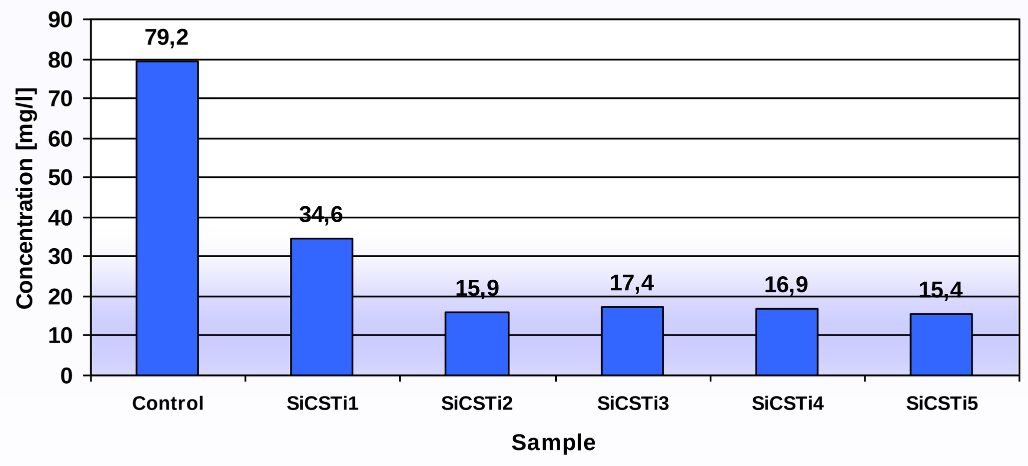


Fig. 7 Degradation activities of synthesized hybrid materials after 4 hours UV radiation

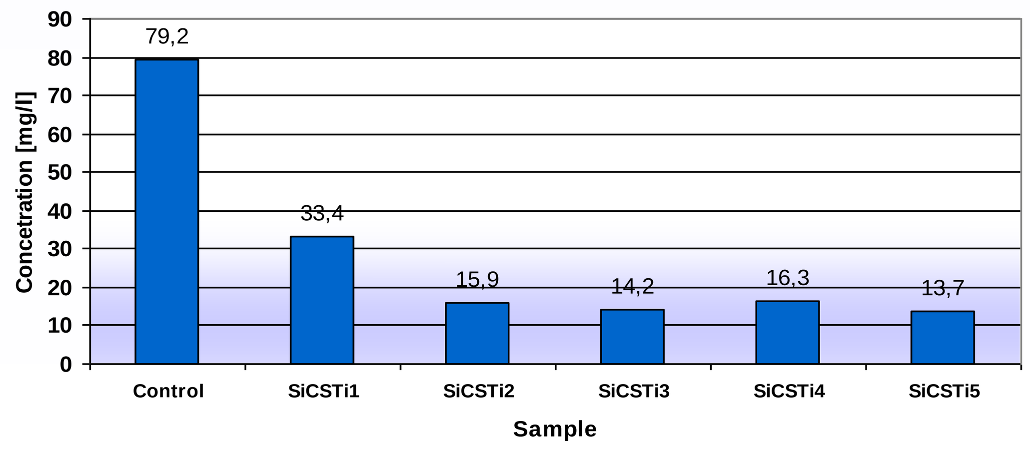


Fig. 8 Degradation activities of re-used hybrid materials after 4 hours UV radiation

Conclusion

The structure and properties of synthesized silica hybrid materials ensure their potential application in ecology fields due to high stability and photocatalytic degradation activity against organic pollutants.

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