New Insights into the Synthesis of Fenton-Like AOP Catalysts for Wastewater Treatment

Nataša Novak Tušar[1,4]*, Ivalina Trendafilova,[1,2] Andraž Šuligoj, [1,3] Alenka Ristić,[1] Albin Pintar,[1] Nataša Zabukovec Logar,[1,4]

[1]National Institute of Chemistry, Hajdrihova 19, SI-1001 Ljubljana, Slovenia

*natasa.novak.tusar@ki.si

[2]Institute of Organic Chemistry with Center of Phytochemistry, Bulgarian Academy of Sciences, 1000 Sofia, Bulgaria

[3]Faculty of Chemistry and Chemical Technology, University of Ljubljana, Večna pot 113, 1000 Ljubljana, Slovenia

[4]University of Nova Gorica, Vipavska 13, 5000 Nova Gorica, Slovenia

Organic compounds are the main class of wastewater pollutants emitted from various industrial processes. Advanced oxidation processes (AOPs) are one of the most efficient chemical methods for catalytic removal of organic compounds from wastewater. Fenton AOP is one of the most cost effective applicable AOP. The Fenton AOPs bottleneck is high cost of the catalysts operating in the heterogeneous systeme. The way to improve the cost-efficiency of Fenton AOP heterogeneous systems is to develop of more efficient but low-cost catalysts that would contribute in satisfying environmental regulations.

We present here important new findings on the direct synthesis of bimetal Cu-Mn containing porous silica catalyst and the effects of structure-directing agent removal from the prepared nanomaterial on the evolution of surface catalytic sites. The extraction-calcination procedure of the structure-directing agent removal led to the formation of Cu and Mn oxo-clusters and Cu and Mn oxide nanoparticles smaller than 5 nm, while the solely calcination procedure led to the mentioned species and in addition to the appearance of CuO nanoparticles 20 nm in size. Catalysts were tested in the Fenton-like AOP catalytic degradation of dyes with different molecular charge (cationic, anionic, and zwitterionic) as model organic pollutants in wastewater at neutral pH. Significantly faster degradation of cationic and anionic dyes in the first 60 min was observed with the catalyst containing larger CuO nanoparticles (> 20 nm) due to the less hindered generation of $^{\bullet}$OH radicals and slower obstructing of the active sites on the catalysts surface by intermediates. However, this was not found beneficial for zwitterionic dye with no adsorption on the catalysts surface, where the catalyst with smaller Cu species performed better.