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Tuning photocatalytic activity of carbon-based assemblies by their morphology and surface functionalization

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A link between morphology of carbons and their performance toward catalytic benzylic oxidation by air has been demonstrated. Catalytic activity and selectivity of pristine and oxidized carbons can be enhanced, altered, or suppressed by visible light. The photocatalytical performance of a carbonaceous material depends on the presence of defects, surface area, porosity, surface oxidation, and covalent conjugation with iron oxide nanoparticles. Adsorption of the hydroperoxide intermediate on the catalyst's surface is suggested as a key process that links the structure of the carbonaceous material with its catalytic activity. The potential of catalysis by carbon black and photocatalysis by graphite nanofibers for greener organic synthesis has been demonstrated. A simple and environmentally friendly selective procedure for cyclohexene-promoted photooxidation of p-xylene, ethylbenzene, and cumene by air in the presence of a pristine or oxidized carbonaceous material has been developed. Depending on the catalyst and conditions, the reaction yields either of the following industrially important products: 4-methylbenzyl hydroperoxide, 4-methylbenzoic acid, 1-phenylethyl hydroperoxide, 2-phenyl-2-propanol, acetophenone with high selectivity and practical extent of conversion. Exposure of the reaction mixture to ambient light further increased the yields. Improved performance of oxidized graphite has demonstrated the potential of surface modification for the design of novel carbonaceous catalysts. Host-guest interaction of reactive intermediates with carbon nanotubes shifts the reaction outcome toward dimerized products. Visible light significantly increases catalytic performance of carbon – iron oxide nanoparticle assemblies, but not their individual components. Modification of carbon nanofibers by oppositely charged functional groups significantly affects morphology and catalytic activity of their assemblies.

Biography

Grigoriy Sereda, PhD in Chemistry, now is Professor of Chemistry, University of South Dakota lead at the State of South Dakota Center for Nanoscale and Advanced Manufacturing. He earned his MSc and PhD in Chemistry from Moscow State University (Russian Federation) in 1992. Currently, his research focuses on a wide range of nanomaterials' synthesis and application in catalysis, industrial polymers, bioimaging, and drug delivery. He is a member of the American Chemical Society, member of the National Examination Committee on Organic Chemistry of the American Chemical Society, tenured faculty at the University of South Dakota and is a author of over 70 publications.

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