MITIGATION - SCIENCE AND TECHNOLOGY ADVANCES FOR CHEMICAL AND BIOLOGICAL CONTAMINATION MITIGATION

Nano Structured Titanium Oxide Materials Capable Of Effective Heterogeneous Reactivity With 2-ethyl Ethyl Sulfide Under Ambient Conditions

Olga Baturina Naval Research Laboratory **Spencer Giles** Naval Research Laboratory **Andrew Purdy** US Naval Research Laboratory **Daniel Ratchford** US Naval Research Laboratory **William Maza** US Naval Research Laboratory

Synthesizing novel TiO2 nanomaterials are valuable for heterogeneous reactivity to address toxic chemical remediation. Titanium oxide nanoflowers (comprising assemblies of nanorods) and nanowires have been synthesized in which both photochemical (1000 nm > l > 400 nm) and chemical heterogeneous reactivity with 2-chloroethyl ethyl sulfide (2-CEES) has been enhanced under ambient conditions. Enhancement of photooxidation with reaction rates of 99 and 168 µmol/g/h (quantum yields of 5.07 x 10-4 and 8.58 x 10-4 molecules/photon) were observed for TiO2 synthesized in the presence of two different alkylphosphonic acids (C14H29PO3H2 and C9H19PO3H2). Additionally, H2Ti2O5□H2O nanowires were synthesized and capable of highly efficient hydrolysis of the carbon-chlorine (C-Cl) bond of 2-CEES without light at a reaction rate of 279.2 µmol/g/h due to high surface area and chemical nature of the titanate structure. These observations are correlated with: 1) generation of new surface defects/states (i.e. oxygen vacancies) as a result of TiO2 grafting by alkyl phosphonic acid that may serve as reaction active sites; 2) better light absorption by assemblies of nanorods in comparison to individual nanorods, 3) surface area differences, and 4) the exclusion of OH groups due to the formation surface functionalization with alkylphosphonic acids via Ti-O-P bonds on the TiO2. These robust materials can be used for highly efficient surface decontamination.

SLG, AMK, APP, DCR, WAM and OAB are grateful to Office of Naval Research and Naval Research Laboratory for financial support.

ACS Applied Materials and Interfaces: "Surface and structural dependent reactivity of titanium oxide nanostructures with 2-chloroethyl ethyl sulfide under ambient conditions"
Spencer L. Giles, Anastasia M. Kastl, Andrew P. Purdy, Asher C. Leff, Daniel C. Ratchford, William A. Maza, and Olga A. Baturina