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Unusual chemical properties of nanostructured SiC

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Nowadays the nanostructured SiC (the nanoparticles, thin layers and porous SiC) is extensively studied in microelectronics, optical, biomedical and catalytic applications. Variable properties of the SiC, in particular the stability of the NPs sols, the recombination of electron-hole pairs, the photoluminescence, the uptake into the living cells and others are determined mainly by surface terminal groups. However the SiC surface chemistry appeared less studied in compare with other semiconductors.

Here we present the peculiarities of the SiC interaction with oxidants (electric current or HNO_3) in the presence of HF and the transformations of SiC NPs (10-20 nm) surface groups under different chemical treatments. The samples were characterized by FT-IR, Raman, XPS, UV-vis absorbance spectroscopy, thermogravimetry, temperature programmed desorption mass-spectrometry (TPD-MS), pH-titration, dynamic light scattering, N_2 adsorption and TEM.

We found that SiC oxidation in the presence of HF resulted in carbon-enriched surface SiC covered mainly by carboxylic acid groups and a water-soluble polymeric product referenced as carbon fluorooxide. Thermal oxidation of the SiC NPs gives a surface layer of SiO_2; no "silicon oxocarbide phase" was found. Surprisingly, the C_3Si-H fragments and aliphatic CH_x fragments appeared in thermally oxidized SiC probably due to the reaction between H_2O from ambient air and strained bonds on the SiC/SiO_2 interface. The procedure of SiC thermal oxidation at t^o = 500 – 900 ^oC followed by the oxide removal was used for controllable reduce of the NPs size accompanied with E increase due to the quantum confinement. The reactions of alkenes with oxide-free SiC, proceeding probably by interaction of C=C fragments with strained C–C bonds of SiC surface, and formation of amides by corresponding amines and $–CO_2H$ groups of HF-oxidized SiC allowed modification of the SiC by alkyl groups.

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