Electronic Structure and Dielectric Properties of Oxidized Nanodiamonds

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Electronic structure of various fractions of the detonation nanodiamonds (ND) were probed using X-ray spectroscopy and X-ray photoelectron spectroscopy. The ND particles have been extracted from the detonation soot using a gradual oxidation procedure and than separated to fractions by centrifugation in the range of G-forces 46-40000 g. The surface composition of ND particles from different fractions was determined from data of TPD and FTIR measurements. X-ray absorption spectra near the K-edges of carbon and oxygen and X-ray photoelectron spectra of the samples were recorded using the Berlin synchrotron radiation facility at the Russian-German laboratory in BESSY-II. The overview X-ray photoelectron spectra of ND fractions detected a presence of nitrogen and oxygen in samples. C1s- and O1s-lines of X-ray photoelectron spectra are split, while N1s-line is presented by a single narrow maximum. The spectral splitting could be caused by the induced charging of ND particles due to oxidized surface layer. Actually, intensity of satellite lines in the C1s- and O1s-spectra was found to correlate with ND agglomerate size and composition of ND surface. The satellite lines drift depending on duration and energy of the exciting synchrotron radiation. With lowering the radiation energy up to 330 eV, the satellite lines were disappeared and C1s-spectra of the samples were interpreted in the terms of chemical shifts under the effect of oxygen-containing functional groups. The precision measurements of electromagnetic response of ND particle agglomerations were performed. Frequency dispersion of constitutive parameters (permittivity, permeability) of nanodiamond powders was measured at low frequencies (10 - 10^6 GHz). The data on the ND agglomeration was obtained. The correlation between electronic structure features and dielectric permeability was found.