Physico-Chemical nanomaterials science

Synthesis and specificity of defects embedding in (100) and (111) oriented CVD diamond nano- and microcrystals grown on Si and Mo substrates using E/H field discharge stabilization

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The arrays of the freestanding diamond nano- and microcrystals (island diamond films) were synthesized using chemical vapor deposition method with direct current glow discharge stabilized by crossed E/H field. The working gas consists of $Ar/CH_4/H_2$ mixture. Mo and Si plates were used as substrates for the deposition. The microcrystalline island films prepared using the mentioned technique were of two preferential orientation – (100) and (111). For the characterization of freestanding microcrystals of (100) and (111) orientation the methods of PL and Raman spectroscopies as well as FTIR spectroscopy and SEM were used. In the structure of the (100)-oriented crystals the nitrogen-related defect complexes N-V-N were registered using PL method, which are not typical for the structure of (111)-oriented ones. However, the N-related complexes such as N-V exist in both (100) and (111)-oriented crystals. It is important to note, in the PL spectra of (100)-oriented crystals on Si substrate one can register the luminescence band that is attributed to recombination with participation of defect levels, which include Si atoms. In the Raman spectra of diamond island films on Mo substrate (texture 111) only the sharp and intensive diamond-related (sp^3 phase) vibration band is ascertained. The spectra of the island films on Si substrates, except diamond related band, include graphite-related bands D and G attributed to vibrations in the structure of sp^2 phase. The intensity of PL bands good correlates with methane concentration. The latter was proved by FTIR measurements for the N-related absorption bands. The thermal treatment in H-atmosphere of the studied samples causes the decrease in the contribution of graphite phase in Raman spectra as well as to decrease in the intensity of luminescence bands attributed to N-V-N defect complexes.