LUMINESCENT DIAMOND COMPOSITES WITH EMBEDDED $Y_3AL_5O_{12}$ DOPED CERIUM AND SRF2 DOPED EUROPIUM PARTICLE FOR RADIATION-RESISTANT IMAGING OF HIGH POWER X-RAY BEAMS

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The new photo- and X-ray luminescence composite screens based on poly- and single-crystal diamond with embedded nanoparticles of oxides and fluorides are developed [1-5].

The particle synthesis of yttrium-aluminum-garnet doped with cerium and strontium fluoride doped with europium were carried out by co-precipitation from aqueous solutions. The compositions with highest intensity values for different X-ray luminescence bands have been determined. Diamond composites were synthesized by chemical vapor deposition in hydrogen-methane gas mixtures in a microwave plasma reactor ARDIS-100.

The effect of annealing in hydrogen and methane-hydrogen plasma at temperatures of 600-950 ^{o}C on the structural-phase and luminescent characteristics of particles has been investigated. The europium in SrF_2:Eu solid solutions at CVD growing conditions changed valency from 3+ to 2+ with simultaneously decreasing overall luminescence intensity, while cerium luminescence in $Y_3Al_5O_{12}$ solid solutions was stable even after similar annealing procedures.

Polycrystalline diamond composite films and membranes with a thickness from 500 nm to 10 μm with embedded synthesized nanoparticles have been manufactured according to discovered optimal regimes of diamond synthesis in microwave plasma. Such composite films and membranes are promising basis for the fabrication of robust X-ray detectors and screens.

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References:

1. V.S. Sedov, S.V. Kuznetsov, V.G. Ralchenko et al. Diamond and Related Materials. 2017, 72, 47-52

2. V. Sedov, S. Kuznetsov, A. Martyanov et al. ACS Appl. Nano Mater. 2020, 3, 1324-1331

3. V.S. Sedov, S.V. Kuznetsov, I.A. Kamenskikh et al. Carbon, 2021, 174, 52-58.

4. S.V. Kuznetsov, V.S. Sedov, A.K. Martyanov et al. Ceramics International. 2021, 47, 13922-13926.

5. S.V. Kuznetsov, V.S. Sedov, A.K. Martyanov et al. Ceramics International. 2022, 48, 12962-12970.