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HIGH-ENERGY EXCITATION OF Zn_2SiO_4 NANOPARTICLES LUMINESCENCE IN ION-IMPLANTED SILICA*

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Zinc-implanted silica films and glasses constitute a popular research topic due to different types of nanoparticles formed within oxide before and after thermal annealing [1, 2]. A nanocrystalline α-Zn_2SiO_4 phase formation in silica glass subsurface layer was observed under pulsed zinc ion implantation and annealing [3]. However, the mechanism of bright green photoluminescence (PL) for such a structure is still a matter of debate having hypotheses of either intrinsic defect or uncontrolled impurity as emission center.

In present study the photoluminescence (PL) and high-energy synchrotron (UV-Vacuum UV) excitation spectra of willemite nanophases formed in glassy and thin-film SiO_2 matrices by means of ion implantation and 900-1000 °C annealing. Pure willemite ceramics is used as reference [3].

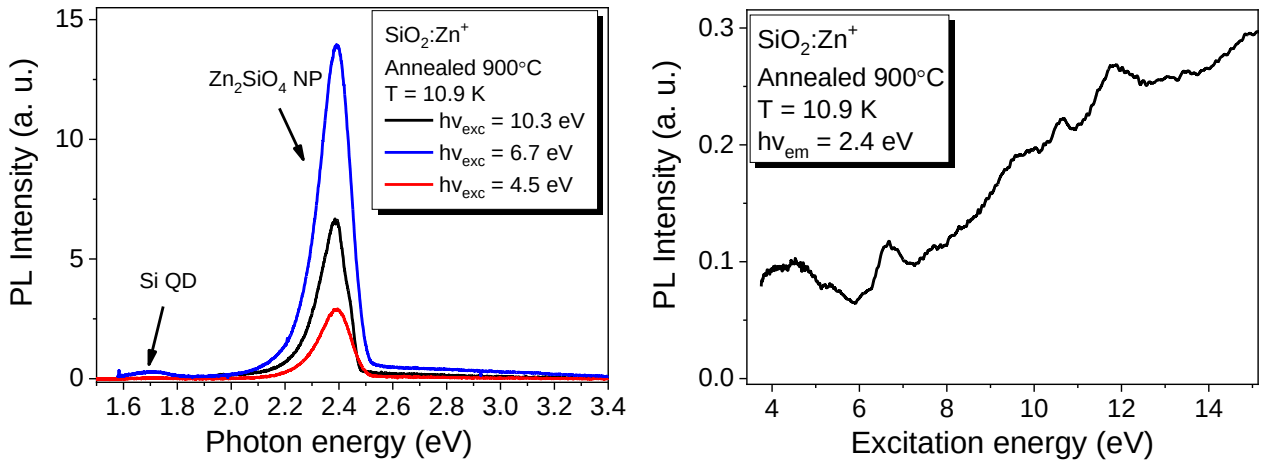

Fig.1. Low-temperature photoluminescence (left) and PL excitation spectra of the silica samples implanted with Zn^+ ions.

Silicon and willemite particles were detected by the characteristic PL bands at 1.7 eV and 2.4 eV, respectively (Fig. 1, left). Green and yellow light emission observed is associated with point defects inside α- and β-Zn_2SiO_4 nanoparticles. The electronic states of point defects are localized to dimensions much smaller than the nanocrystal size, so the PL band positions are similar to that of bulk willemite [4]. Different PL excitation mechanisms were distinguished for implanted silica, including energy transfer from free and self-trapped excitons showing up as the VUV PLE bands in the 10 eV – 12 eV region (Fig.1, right). The results obtained may be used to tailor the luminescent properties of the Zn-containing oxide nanocomposite in wide temperature range.

REFERENCES

[1] Khramov, E.V., Privezentsev, V.V., Palagushkin, A.N., Shcherbachev, K.D., Tabachkova, N.Y. "XAFS and TEM Investigation of Nanocluster Formation in $^{64}Zn^+$ Ion-Implanted and Thermo-Oxidized SiO_2 Film" Journal of Electronic Materials, 49 (12), pp. 7343-7348, 2020.

[2] Czarnacka, K., Koltunowicz, T.N., Makhavikou, M., Parkhomenko, I., Komarov, F.F. "Electrical and optical properties of SiO2 thin layers implanted with Zn ions" Acta Physica Polonica A, 136 (2), pp. 274-277, 2019.

[3] A. Zatsepin, E. Buntov, N. Gavrilov, and H.-J. Fitting, "Ion-beam synthesis and thermal behaviour of luminescent Zn_2SiO_4 nanoparticles in silica glasses and films" Phys. Status Solidi B 253, No. 11, pp. 2180–2184, 2016.

[4] A. Zatsepin, E. Buntov, V. Kortov et al. "Willemite photoluminescence in Zn-implanted silica glasses" Phys. Stat. Sol. C, 12, 1355–1358, 2015.

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