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Effect of Silver Metallic Particles on the Luminescence Characteristics of Samarium doped Barium borate Glasses*.

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Abstract: Barium borate glasses embedded with Sm^{3+} and/or Silver oxide were made by the melt quenching technique. Silver particles were induced by heat treatment. Imaging and spectroscopy measurements were performed to characterize the samples.

In the past sodium borate glasses embedded with rare-earth ions were investigated for luminescent devices [1-3]. Sodium borate glasses have good transmission in the visible wavelength region, but they lack mechanical strength. So, we chose Barium borate glasses for this investigation. Barium borate glasses were made by the melt quenching technique. For this purpose, we obtained pure chemicals from Alfa-Aesar company. Appropriate quantities of Barium carbonate, boron trioxide, Samarium oxide and/or silver oxide chemicals were weighed and then manually mixed in a mortar for 45 minutes. The mixture was poured into an alumina crucible and heated in a tube furnace at 1200°C for an hour. The resulting melt was poured into aluminum mold and allowed the melt to cool to room temperature naturally, in the ambient air. This method yielded a good glass that is much stronger than the sodium borate glass. The resulting glasses were polished with different grades of sandpaper to smoothen the surfaces.

Samarium and Silver were chosen as dopants because Sm^{3+} and Ag nanoparticles exhibit absorption in the vicinity of 405 nm. Hence it is possible to investigate interaction mechanisms between the metallic nanoparticles and Sm^{3+} ions. The samples were heat treated above the glass transition temperature to induce nanoparticles. Optical microscope images revealed the formation of micron size Ag particles, too. Optical absorption spectrum of a co-doped sample revealed spectral changes and enhancement of Sm^{3+} transitions in the vicinity of plasmon absorption wavelength. The 375, 405 nm diode lasers and 308nm Excimer laser were used to induce fluorescence from the samples. Initial investigation revealed a drastic reduction in the Sm^{3+} emission intensity. Both Sm^{3+} and Ag nanoparticles exhibit absorption in the vicinity of 405 nm. It appears that some of the Sm^{3+} excited state population is transferred to the surrounding Ag metallic particles. However, when the co-doped sample was heat treated at 530°C for 17 hours the emission intensity of co-doped sample increased again to the original value, same as that observed before heat treatment. This indicates that metallic particle size has changed after prolonged heat treatment, consequently shifting the plasmon absorption wavelength. Lifetimes of the excited levels is measured by monitoring emission at different wavelengths. Further work is in progress to understand the effect of metallic particles on the Sm^{3+} luminescence.

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