Photoluminescence of Ag and Li nanoclusters dispersed in glass host

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Photoluminescence of silver (Ag) and Lithium (Li) nanoclusters embedded in different hosts has recently been attracted substantial interest because of the promising applications in optical nanolabels, visible light sources, optical recording, and also in down conversion of solar spectrum [1,2].

Bulk oxyfluoride glasses doped with Ag nanoclusters have been prepared using the melt quenching technique, for the first time to our knowledge. When pumped in the absorption band of Ag nanoclusters between 300 to 500 nm, these glasses emit a very broad luminescence band covering all the visible range with a weak tail extending into the near infrared. The maximum of the luminescence band and its color shifts to the blue with a shortening of the excitation wavelength and an increasing ratio of oxide to fluoride components, resulting in white color luminescence at a particular ratio of oxide to fluoride; with a quantum yield above 20%. Preliminary data has been published in [3].

Li-Yb^{3+} co-doped nano-crystalline ZnO have been synthesized by a method of thermal growth from the salt mixtures. X-ray diffraction, transmission electron microscopy, atomic absorption spectroscopy and optical spectroscopy confirm the doping and indicate that the dopants may form Li-Li and Yb^{3+}-Li based nanoclusters. When pumped into the conduction and exciton absorption bands of ZnO between 250 to 425 nm, broad emission bands of about 100 nm half-height-width are excited around 770 and 1000 nm, due to Li and Yb^{3+} dopants, respectively. These emission bands are activated by energy transfer from the ZnO host mostly by quantum cutting processes, which generate pairs of quanta in Li (770 nm) and Yb^{3+} (1000 nm) emission bands, respectively, out of one quantum absorbed by the ZnO host. These quantum cutting phenomena have great potential for application in the down-conversion layers coupled to the Si solar cells [2,4].

References

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Figures

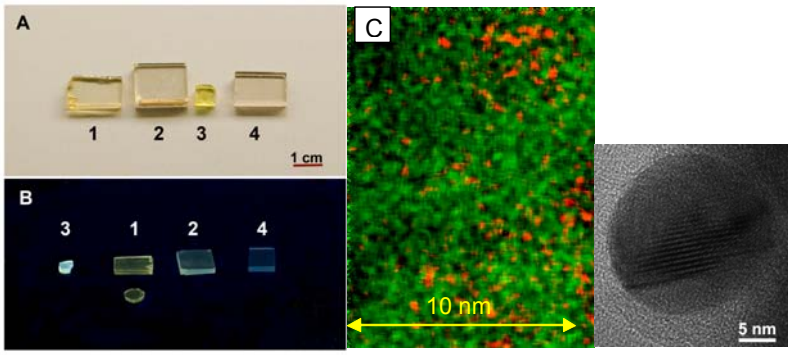

Fig.1. (a) Daylight picture of as-prepared glass samples: 1 is the basic glass doped with 10 wt% $AgNO_3$; 2 is the basic glass doped with 1 wt% $AgNO_3$; 3 is the oxygen-enriched glass $51(SiO_2)14(AlO_{1.5})22.5(CdF_2)10(PbF_2)2.5(ZnF_2)$, mol%, doped with 5 wt% $AgNO_3$; 4 is the undoped basic glass. b) Luminescence image of the same glass samples, marked respectively, excited with a UV lamp CAMAG at 366 nm. c) Energy filtered transmission electron microscope image of a piece of the basic glass doped with 1 wt% $AgNO_3$ and 3.5 mol% of YbF_3: the red color represents Ag and the green color represents Yb, respectively. d) TEM image of a single Ag nanoparticle grown by intentional heat-treatment of the basic glass doped with 1 wt% $AgNO_3$: the glass was treated at 350ºC for 1 hour.

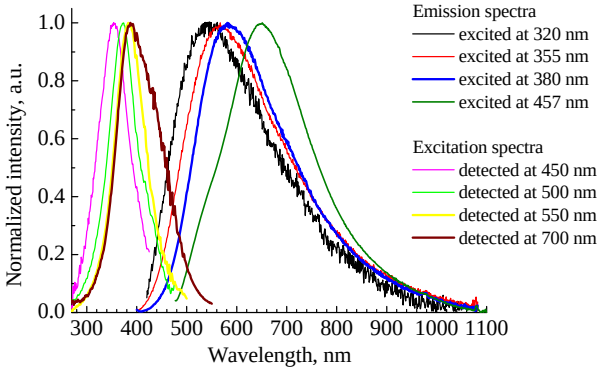

Fig. 2. Normalized emission and excitation spectra of the basic glass doped with 5 wt% $AgNO_3$. Emission and excitation wavelengths are post-signed, respectively.

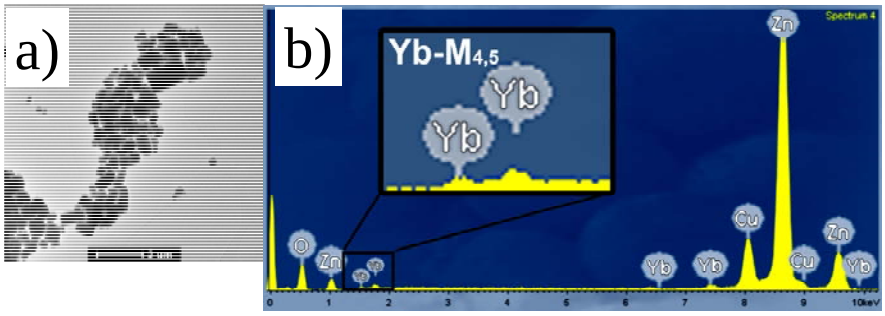

Fig. 3. (a) TEM image and (b) TEM EDX spectrum of ZnO:Li-Yb nanopowder. The Yb-M4,5 peaks between 1.50 and 2.00 keV are indicated and zoomed. Other peaks corresponding to the Yb, Zn and O are also labeled. Cu and C peaks are due to the sample holder.

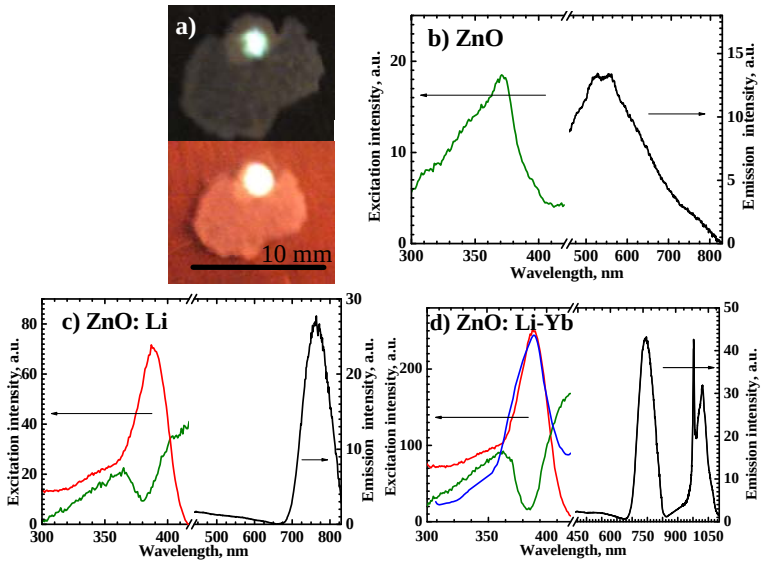

Fig. 4. (a) A piece of ZnO:Li-Yb nanopowder pellet showing a bright luminescent spot when illuminated by an invisible laser beam of Ar laser at 355 nm. (b,c,d) Excitation (left side) and emission (right side, black curves) spectra of ZnO (b), ZnO:Li (c) and ZnO:Li-Yb (d) nanopowders; in excitation spectra the green curves correspond to detection at 550 nm (intrinsic defect emission), red curves to detection at 770 nm (Li emission) and blue curve to detection at 980 nm (Yb emission).