VUV synchrotron radiation spectroscopy of $Li_2B_4O_7$ glass ceramics.

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Abstract

The luminescence properties of $Li_2B_4O_7$ glass ceramics are very interesting because of their high optical transparency in optical applications. $Li_2B_4O_7$ glass ceramics are desirable candidates for most device applications, such as light shutters, modulators, color filters, memories and image storage devices.

In this report, for the first time the luminescence properties of $Li_2B_4O_7$ glass ceramics doped with Eu, Co, Cr, Ce, Mn, Ni and Fe were studied under vacuum ultraviolet (VUV) and ultraviolet (UV) synchrotron radiation (3.6 – 25.0 eV) emitted from DORIS III storage ring at SUPERLUMI station at HASYLAB, DESY, Hamburg, in the wide temperature range of 10–293 K.

As it is known for some $Li_2B_4O_7$, their experimentally determined band gap energy is 3.3 - 3.7 eV and thus use of synchrotron radiation provides ideal conditions for the multiplication of electronic excitations, when each absorbed photon produces two or more electronic excitations. To study this effect, we have measured the appropriate excitation spectra of the intrinsic emission (~600 nm) in the case of undoped, Ce or Eu-doped $Li_2B_4O_7$, or that of Fe-related emission (~440 nm) in the case of Fe-doped sample.

In all cases, a prominent threshold for excitation multiplication at ca. 14.0 eV (as high as (3-4) Eg) was discovered. The results obtained are compared with the appropriate reflection spectra, all measured at 10 K. The temperature dependence of the intrinsic emission band was studied in details in temperature range 10-150 K and the appropriate quenching parameters are determined.

Reflectivity measurements

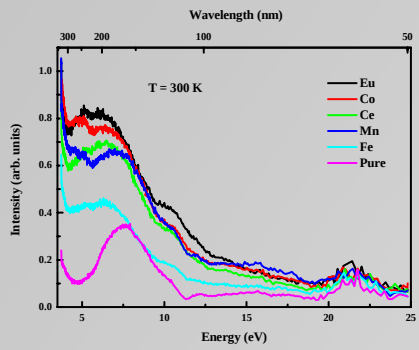

Fig. 1. Reflectivity spectra of some pure and doped $Li_2B_4O_7$ samples at 300 K

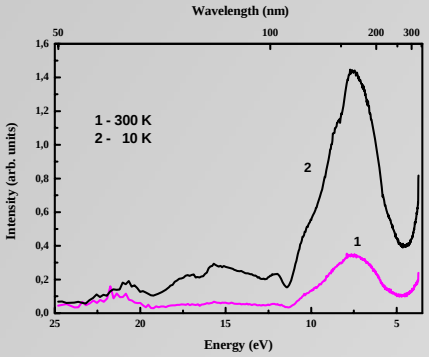

Fig. 2. Reflectivity spectra of pure (or undoped) PLZT samples at 10 K and 300 K

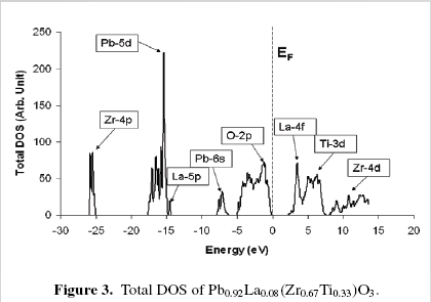

Figure 3. Total DOS of $Pb_{0.92}La_{0.08}(Zr_{0.67}Ti_{0.33})O_3$.

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Luminescence measurements

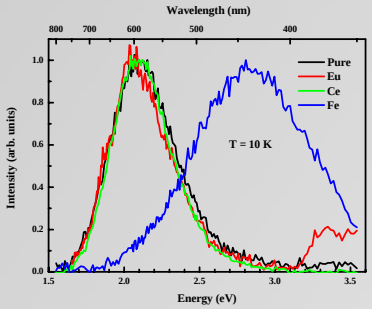


Fig. 4. Normalized emission spectra

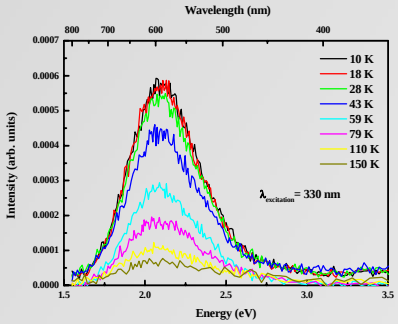


Fig. 5. Temperature dependence of 600-nm band in pure $Li_2B_4O_7$

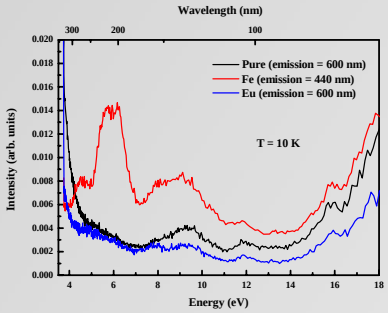


Fig. 6. Excitation spectra

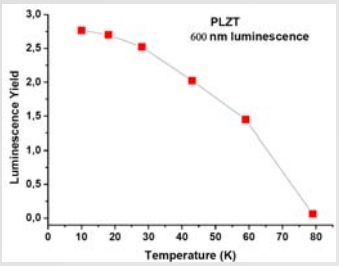
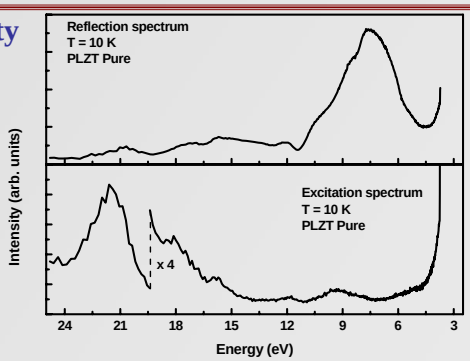


Fig. 7. Temperature quenching of 600-nm band in pure PLZT. E_{act} = 14 meV

Excitation vs Reflectivity



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