OPTICAL AND UPCONVERSION PROPERTIES OF A Ho^{3+} DOPED ZnO-TeO_2 GLASS

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Tellurite based glasses of various compositions doped with rare-earth ions have generated much interest recently not only as possible optical amplifiers but also as possible solid-state laser hosts. Tellurite glasses possess one of the lowest phonon energies of the oxide glasses. Combine this with a high refractive index that not only facilitates waveguiding but also benefits radiative transitions of RE ions and one has an attractive host for an upconversion laser. Recently, there has been a significant amount of interest in Ho^{3+} doped crystals and glasses as upconversion materials, with several groups demonstrating continuous wave (cw) green upconversion lasing from Ho^{3+} doped glass fibers pumped with red light. In this study we examine the optical and upconversion properties of a 19ZnO-80TeO_2-1Ho_2O_3 glass.

After excitation with 457.9 nm radiation at room temperature (RT) and 78 K, the glass exhibits four distinct emission bands in the visible and near-infrared portions of the spectra corresponding to the $^5F_3 \rightarrow {}^5I_8$ (480-500 nm), ($^5F_4$, $^5S_2$) $\rightarrow {}^5I_8$ (525-575 nm), $^5F_5 \rightarrow {}^5I_8$ (630-680 nm) and ($^5F_5$, $^5S_2$) $\rightarrow {}^5I_7$ (735-775 nm) transitions (Figure 1).

Blue and yellow-green anti-Stokes emission corresponding to the $^5F_3 \rightarrow {}^5I_8$ and ($^5F_4$, $^5S_2$) $\rightarrow {}^5I_8$ transitions respectively was observed after excitation with 645 nm radiation at RT from a dye laser that excites the $^5F_5$ level. To determine the number of photons involved in the upconversion process the intensity of the upconverted blue and green emission was measured as a function of the 645 nm excitation intensity. The upconverted luminescence exhibited a quadratic dependence on the pump power indicating a two-photon upconversion process. The upconversion luminescence is thought to occur through an excited state absorption (ESA) upconversion process.

Upon excitation with 754 nm radiation from a Titanium Sapphire laser that excites the $^5I_4$ level, anti-Stokes emission corresponding to the ($^5F_4$, $^5S_2$) $\rightarrow {}^5I_8$ and $^5F_5 \rightarrow {}^5I_8$ transitions were observed. The ($^5F_4$, $^5S_2$) $\rightarrow {}^5I_8$ transition demonstrated a quadratic dependence on the power of the pump beam indicating that two photons were involved in the excitation process. Again an excited state absorption (ESA) process is thought to be the dominant mechanism. Mechanisms for the two upconversion processes are also proposed.

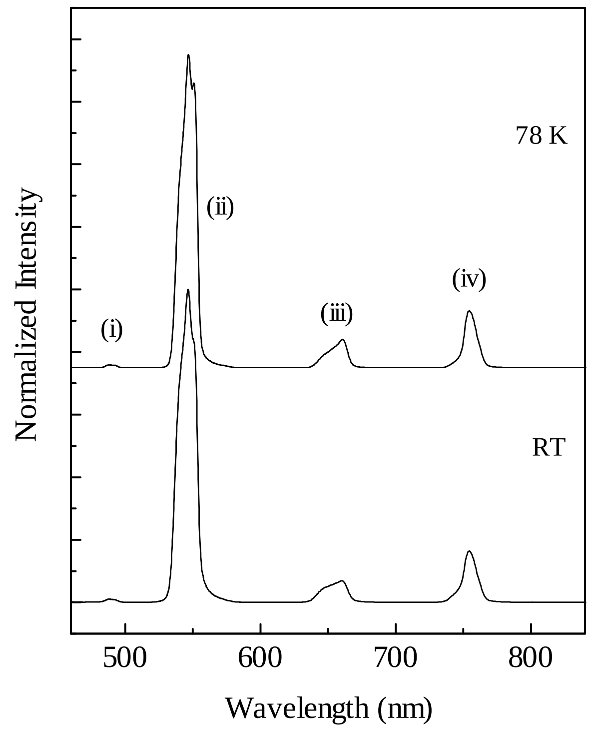

Figure 1: RT and 78 K luminescence of 19ZnO-80TeO_2-1Ho_2O_3 glass upon excitation at 457.9 nm. (i) $^5F_3 \rightarrow {}^5I_8$ (ii) ($^5F_4$, $^5S_2$) $\rightarrow {}^5I_8$ (iii) $^5F_5 \rightarrow {}^5I_8$ (iv) ($^5F_4$, $^5S_2$) $\rightarrow {}^5I_7$

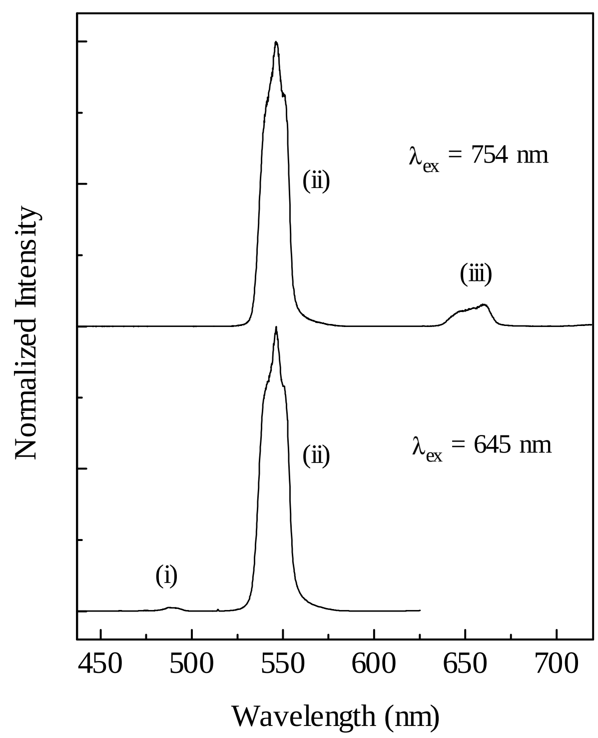

Figure 2: RT upconversion luminescence of 19ZnO-80TeO_2-1Ho_2O_3 glass upon excitation at either 645 nm or 754 nm. (i) $^5F_3 \rightarrow {}^5I_8$ (ii) ($^5F_4$, $^5S_2$) $\rightarrow {}^5I_8$ (iii) $^5F_5 \rightarrow {}^5I_8$