Yttrium sesquioxide ($Y_2O_3$) doped with trivalent lanthanide ions has received much attention in recent years due to its excellent laser host properties [1]. $Y_2O_3$ has superb optical and mechanical properties including a wide transmission window from 250 nm to about 8 μm and a thermal conductivity that is two times bigger than in YAG. CeO$_2$ based materials are candidates for variety of potential applications from solid electrolytes for solid oxide fuel cells (SOFC), oxygen sensors, catalyst to the host for lanthanide ions. Holmium ion ($Ho^{3+}$) has been chosen as a dopant because it shows laser action at different wavelengths, from 550 nm to 3.9 μm, in a variety of hosts and in combination with other lanthanides ions is suitable for generating visible upconversion emission after excitation in NIR [2].

Nanocrystalline $Y_2O_3$:Ho and CeO$_2$:Ho have been synthesized by solution combustion method using ethylene glycol as the fuel. Materials are characterized by using X-ray powder diffraction (XRD) and transmission electron microscopy (TEM). Luminescence properties of $Y_2O_3$:Ho and CeO$_2$:Ho are studied using two Raman spectrometers with excitation in NIR and visible.

Using X-ray diffraction measurements we have determine average crystallite size of $Y_2O_3$:Ho and CeO$_2$:Ho. The variety in the sizes of particles in both CeO$_2$:Ho and $Y_2O_3$:Ho was observed by TEM (Fig. 1). However, the average values correspond to average crystallite sizes determined from XRD patterns. The appearance of the rings in SAED patterns (inserts in Fig 1) indicated nanosized crystallites as observed by TEM and determined from broadening of the XRD lines.

Luminescence properties have been studied by using Raman spectrometers with excitation in NIR and visible. All bands present in spectra are assigned to $4f^{10} \rightarrow 4f^{10}$ transitions of Ho$^{3+}$.

Combustion synthesis using ethylene glycol as the fuel is a fast and inexpensive method for synthesis of nanocrystalline oxide materials doped with lanthanide ions. This study clearly demonstrates the use of Raman spectrometers for studying luminescence of lanthanide ions. Raman instruments are equipped with all necessary parts to record luminescence spectra in visible and NIR region. Due to the inherent weakness of Raman effect detectors in Raman instruments are very sensitive and that is a great advantage for studying lanthanide luminescence. Modern Raman instruments are also equipped with different lasers so the choice of excitation source is easy.


Figure 1: TEM and SAED of: a) CeO$_2$:Ho and b) Y$_2$O$_3$:Ho