Hyper-Rayleigh Scattering from Orthorhombic NaNbO$_3$ Nanocrystals

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The first-order hyperpolarizability of orthorhombic sodium niobate (NaNbO$_3$) nanocrystals was measured in this work for the first time. Samples transparent in the visible and near-infrared were synthesized by using the Pechini sol-gel method and the procedure described in reference[1]. A white fluffy powder was obtained after calcination of the powder at temperatures of 600, 700, 800 and 900 °C. X-Ray Powder Diffraction was used to investigate the crystalline structure of the nanocrystals using the CuK$_\alpha$ radiation (wavelength: 1.54 Angstrons). The size distribution of the nanocrystals was determined using the DLS technique and the average size of the nanocrystals depends on the calcination temperature, e.g., it is approximately 185 nm for the sample calcined at 800 °C. Diffuse reflectance spectra were measured by using a commercial spectrophotometer operating from 200 to 1300 nm and BaSO$_4$ powder as reference. The spectra of all samples present a large transparency window from 400 to 1200 nm. The Hyper-Rayleigh Scattering technique was employed to analyze the second harmonic scattered light generated by the nanocrystals by using a Q-switched Nd:YAG laser (1064 nm, 6 ns, 10 Hz) and the external reference method was applied, with para-nitroaniline as the standard reference [2]. The first-order hyperpolarizability $\beta_{nc} = 8.5 \times 10^{-24}$ esu was measured for nanocrystals with average size of approximately 185 nm. This result has the same order of magnitude than the hyperpolarizability of LiNbO$_3$ and KNbO$_3$ nanocrystals [3] with average size of 125 nm and indicates that NaNbO$_3$ nanocrystals can be used as nanoprobes for nonlinear microscopy.