Optical Properties of $BaWO_4$:Ce Crystals

D. Wlodarczyk[1], M. Berkowski[1], M. Głowacki[1], S. Kaczmarek[2], Z. Kowalski[2], A. Wittlin[1], H. Przybylinska[1], Ya. Zhydachevskyy[1], A. Suchocki[1,3]

[1]*Institute of Physics, Polish Academy of Sciences, Aleja Lotnikow 32/46, PL-02668 Warsaw, Poland*
[2]*Institute of Physics, Faculty of Mechanical Engineering and Mechatronics, West Pomeranian University of Technology in Szczecin, Al. Piastów 17,70-310 Szczecin, Poland*
[3]*Institute of Physics, Kazimierz Wielki University, Weyssenhoffa 11, 85-072 Bydgoszcz, Poland*

Barium tungstate crystals are interesting and relatively new medium for stimulated Raman scattering for applications in Raman shifters of laser radiation [1]. Good quality $BaWO_4$ crystals can be grown by Czochralski technique and doped with rare-earth ions. Doping with trivalent ions require charge compensation which may be provided, for example, by structural defects or proper codoping with alkaline metal ions. Crystals posses sheelite structure with the space group $I4_1/a$.

Results of studies of $BaWO_4$:Ce crystals and crystals codoped with Na are presented in this work. Optical absorption in the vis-UV and infrared range and Raman spectra have been studied. In the UV range the crystals shows typical absorption for Ce^{3+} with two bands peaked at 320 nm and 285 nm, which are associated with lowest energy 4f-5d transitions. However no Ce^{3+} luminescence is observed at room temperature, in spite of some reports on this subject [2].

In the mid-infrared range several absorption bands are visible with use of Fourier-Transform spectroscopy which may be associated with lattice absorption. Besides of lines associated with single phonon modes in the range up to 1000 cm^{-1} the additional lines appear around 1700 cm^{-1} and around 2600 cm^{-1}. Origin of these lines is discussed in this work.

Raman spectra at room temperature show very sharp lines with the highest energy line at 927 cm^{-1}. Some additional much broader lines are observed above 1200 cm^{-1} [3]. Their origin is most probably associated with combination of various phonon modes.

In addition to that very sharp lines due to the 4f-4f transitions in the Ce^{3+} ions are visible around 2200 cm^{-1} and 2350 cm^{-1}. There are at least four of these lines in each group which is most probably related to the multisite structure of RE doping in these crystals. The crystal field analysis allows identifying nature of these lines. The lines associated with Ce^{3+} ions are very strongly coupled with the lattice and they undergo very important broadening with increase of temperature.

Acknowledgements. This work was supported by the Polish National Science Center (project 2015/17/B/ST5/01658).

[1] Pavel Cerný, Helena Jelínková, Tasoltan T. Basiev, and Peter G. Zverev, *IEEE J. Quantum Electronics* **38** (2002) 1471.
[2] K.V. Dabre, S.J. Dhoble, Jyoti Lochab, *J. Luminescence* **149** (2014) 348.
[3] Donggang Ran, Hairui Xia, Shangqian Sun, Peng Zhao, Fengqin Liu, Zongcheng Ling, Wenwei Ge, Huaijin Zhang, Jiyang Wang, *Cryst. Res. Technol.* **41** (2006) 1189.