

MAGNONS AND PHONONS EXCITATIONS IN NANOSIZED NiON. Mironova-Ulmane¹, A. Kuzmin¹, T. Dizhbite², I. Sildos³, M. Pärss³, J. Grabis⁴¹Institute of Solid State Physics, University of Latvia, Kengaraga street 8, Latvia²Latvian State Institute of Wood Chemistry, Riga, Latvia³Institute of Physics, University of Tartu, University Riia street 142, EE-2400 Tartu, Estonia⁴Institute of Inorganic Chemistry of Riga Technical University, Salaspils, Latvia

Magnon excitations in microcrystalline nickel oxide (NiO) were successfully probed in the past by Raman spectroscopy [1]. In this work, we present for the first time the Raman scattering in nanosized NiO powders, produced by the plasma synthesis and a precipitation method.

The average NiO particle size was estimated from the BET specific surface area measurements. Single-crystal NiO was used for comparison. Raman experiments were conducted at room temperature using 3D scanning confocal microscope with spectrometer *Nanofinder-S* (SOLAR TII, Ltd.). The low temperature Raman studies were carried out by using an home-made micro-Raman spectrometer based on a standard Olympus microscope equipped with single grating Andor Shamrock 303i spectrometer

The RT Raman spectrum of single-crystal NiO shows several bands in the probed region above 400 cm⁻¹. The first four bands have vibrational origin and, according to assignment in [2], correspond to one-phonon (1P) TO and LO modes (at ~570 cm⁻¹), two-phonon (2P) 2TO modes (at ~730 cm⁻¹), TO + LO (at ~906 cm⁻¹) and 2LO (at ~1090 cm⁻¹) modes. The last strongest band at 1490 cm⁻¹ is due to a two-magnon (2M) scattering [2]: it is well observed at RT due to a high value of the Néel temperature ($T_N = 523$ K).

The phonon related part of the Raman spectra in nanosized NiO powders is rather similar to that in the single-crystal NiO. It consist of one-phonon (1P) band at ~570 cm⁻¹ and two-phonon (2P) bands at ~730 cm⁻¹, ~906 cm⁻¹ and ~1090 cm⁻¹. However, the 1P band becomes more pronounced in powders due to the presence of defects or surface effect, but the three 2P bands appear to be more broadened, especially the band at 906 cm⁻¹, which practically disappears. At the same time, the two-magnon (2M) band, observed in the single-crystal NiO at 1490 cm⁻¹, experiences dramatic decrease of intensity in nanopowders, becoming undetectable for <100 nm crystallites size at RT.

The temperature dependence (10-250 K) of the Raman signal in nanosized NiO powders was also studied and shows two effects. First, the two-magnon peak is present in both samples, and its behaviour follows the expected one for three-dimensional, cubic antiferromagnets: upon heating, the peak broadens, and its position shifts to lower energies. In bulk NiO the two-magnon peak vanishes at around the Néel temperature [2,3]. Note also that the two-magnon lineshape in nanopowders at 10 K is very close to that observed in [4,5] for bulk NiO and consist of the main peak and three shoulders at the high energy side. Second, the one-phonon band at ~500 cm⁻¹ remains nearly unchanged for 1500 nm size powder at all temperatures, but in 100 nm size powder this band has a different shape and a sharp peak at 450 cm⁻¹ grows up on top of the band upon cooling.

- [1] Dietz R E, Parisot G I and Meixner A E 1971 *Phys. Rev. B* **4** 2302
- [2] Dietz R E, Brinkman W F, Meixner A E and Guggenheim H J 1971 *Phys. Rev. Lett.* **27** 81
- [3] Massey M J, Chen N H, Allen J W and Merlin R 1990 *Phys. Rev. B* **42** 8776
- [4] Press M, Mayer M, Knoll P, Lo S, Hohenester U and Holzinger-Schweiger E 1996 *J. Raman Spectroscopy* **27** 343
- [5] Grimsditch M, McNeil L E and Lockwood D J 1998 *Phys. Rev. B* **58** 14462