Poster Presentation

MS74.P22

Nanoindentation and ellipsometry of Li₂ZnTi₃O₈ & Zn₂TiO₄ single crystals

L. Perfler¹, V. Kahlenberg¹, C. Wikete², R. Kaindl³

¹University of Innsbruck, Institute of Mineralogy and Petrography, Innsbruck, Austria, ²University of Innsbruck, Institute for Structural Engineering and Material Sciences, Innsbruck, Austria, ³Joanneum Research, Institute for Surface Technologies and Photonics, Niklasdorf, Austria

Spinel-type Li₂ZnTi₃O₈ and Zn₂TiO₄ are useful for various industrial applications due to their interesting chemical and physical properties, for example, as promising anode materials in Li-ion batteries or as components in dielectric devices [1]. Since Li₂ZnTi₃O₈ and Zn₂TiO₄ are expected to have high refractive indices (n calc. = 2.33 and 2.26) we tried to characterize these materials in more detail including single-crystal X-ray diffraction, nanoindentation, spectroscopic ellipsometry and electron microprobe analysis. Single crystals of Li₂ZnTi₃O₈ and Zn₂TiO₄ were grown directly from melt at 1723 K and 1873 K, respectively. Fragments of sintered polycrystalline Li₂ZnTi₃O₈ and Zn₂TiO₄ precursors were placed on an iridium sheet and fired in a muffle furnace from 1273 to 1723/1873 K with a heating ramp of 15 K/min. After a dwell time of 3 min the melt was cooled down to 1473 K with a ramp of 10 K/min and subsequently quenched in water. Structural investigations of the Li₂ZnTi₃O₈ and Zn₂TiO₄ single crystals resulted in the following basic crystallographic data: cubic, P4₃32, a = 8.3697(2) Å, V = 586.31(3) Å³, Z = 4 and Fd-3m, a = 8.46230(17) Å, V = 605.99(2) Å³, Z = 8, respectively. Nanoindentation experiments were performed with a Berkovich diamond indenter tip to determine the hardness and elastic modulus of Zn₂TiO₄ and Li₂ZnTi₃O₈. For sample preparation the single crystals were embedded in resin and polished to a mirror-like surface finish. More than 150 indents with a distance of 10 µm were made with a maximum load of 20 mN. Analysis of the load-displacement curves for Zn₂TiO₄ revealed a hardness of 10.51 ± 0.39 GPa and a reduced elastic modulus of 180.90 ± 3.92 GPa. Atomic force micrographs displayed indents with a max. depth of 288 ± 5 nm. Li₂ZnTi₃O₈ exhibited a hardness of 6.86 ± 0.45 GPa and a reduced elastic modulus of 148.88 ± 6 GPa. Zn₂TiO₄ showed a dispersion of 0.09 due to the variation of the refractive index from 2.24 (430,8 nm, Fraunhofer G line) and 2.15 (686,7 nm, B line).


Keywords: Li₂ZnTi₃O₈, Zn₂TiO₄