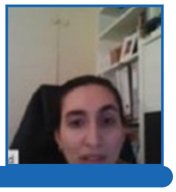
Journal of Materials Science and Nanomaterials



Nano-scale effects on the phase diagrams of rare-earth oxides

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Abstract

Rare-earth (RE) oxides are important in myriad fields: metallurgy, catalysis and ceramics. It is known they undergo polymorphic phase transitions with temperature or pressure changes. However, the phase diagram of RE oxides in the nano scale might differ from the phase diagrams for bulk. We suggest that grain size in the nano scale is a free thermodynamic parameter and also determines the obtained crystallographic phase along with temperature and pressure. To verify this hypothesis, in a sol-gel process separated from each other nano particles of Sm2O3, Eu2O3 and Gd2O3 were produced in a neutral MgO matrix. This preparation method provided isolation of the RE oxide particles and thus hindering the grain growth process associated with increasing the temperature. There is a difference in the thermal expansion coefficient between MgO and the RE, which causes a high hydrostatic pressure on the RE oxide particles after cooling to room temperature, introducing undesired factor. Another method to slowdown the thermal growth is by providing gradual heating instead inserting the samples directly into the hot furnace. During the slow heating process the samples stay long time in the lower temperature range were the grain growth is very slow forming very fine structured oxides from the xerogel. Further heating needs recrystallization which is much slower process than growing oxides directly from the xerogel. Both approaches permitted to resolve the controversies around the unusual phase transformation from Low Temperature (LT) cubic to High Temperature (HT) monoclinic structure in the three oxides. The cubic structure is the equilibrium structure for less than 100 nm grain size, since it has a lower surface energy than the monoclinic one. The monoclinic is the stable structure for larger grains, where the equilibrium phase is that with minimum chemical energy. Slowing down the thermal growth was effective to separate two thermodynamic parameters, temperature and area to volume ratio. As a result it was possible to determine the phase stability for the three RE oxides as function of grain size and temperature.

Biography

Chen Avin is acting as a associate professor and as a head of the unit in the department of communication systems engineering in ben-gurion university of the negev, Israel. He is an active editor or member of editorial board of scientific for the IEEE transactions on network and service management. He is a member in the societies of association for computing machinery and the institute of electrical and electronics engineers. He has around 20 years of teaching experience with excellent research output in communication systems engineering.

3rd World Congress on Nanomaterials | August 28-29, 2020

Citation: Chen Barad, Nano-scale effects on the phase diagrams of rare-earth oxides, Nanomaterials Congress 2020, 3rd World Congress on Nanomaterials, August 28-29, 2020 | Webinar, 07