Optical Properties of Segregates in Functionalized Earth Alkaline Oxide Nanoparticle Powders

Hasan Razouq, Thomas Schwab, Gregor Zickler and Oliver Diwald

Chemistry and Physics of Materials, University of Salzburg, 5020 Salzburg, Austria

The knowledge-based design of nanoparticle based oxide ceramics is an important prerequisite for both, basic research in the physical chemistry of materials and the manufacture of advanced materials with unprecedented properties. [1] A possible approach to substitute currently used rare earth or heavy metals in optical applications is the use of highly dispersed alkaline earth oxides with emission properties in the visible range of light, emerging from low coordinated surface sites. [2]

In this study, a hybrid chemical vapor synthesis approach was used to incorporate Ba^{2+}-ions into the nanocrystalline MgO host lattice within the Mg-combustion flame. Control over composition is achieved by adjustment of the evaporation rate of the metal-organic Ba-precursor. A subsequent applied vacuum annealing step promotes ion diffusion within the non-equilibrium solids and leads to particle reorganization and, ultimately, to the surface decoration of the MgO nanocrystals with BaO segregates.

Structural investigation performed with the help of XRD and TEM revealed Ba-concentration dependent trends in nanoparticle growth. Moreover, annealing provides means to control impurity localization [3] and triggers Ba-segregation within the MgO nanocrystals, as studied with EDX. Moreover, the surface functionalization of the MgO nanoparticles leads to significant changes of the optical properties, showing BaO specific absorption bands (UV/Vis) and both, a strong increase and a shift of the materials' photoemission properties into the range of visible light.

The here discussed results clearly show the possibility to tune and control structural and optical material properties within the MgO host lattice and on its particle surfaces as a function of impurity admixture and annealing.

[1] K. Faber et al., J. Am. Ceram. Soc. 2017, 100, 1777-1803.

[2] A. Sternig et al., J. Materi. Sci. 2015, 50, 8153-8165.

[3] M. Niedermaier et al., J. Phys. Chem. C 2017, 43, 24292-24301.