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Effect of Graphene on the Structural and Optical Properties of Ceria:Graphene Nanocomposites

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Abstract : Bandgap engineering of CeO_2 nanocrystals is of high interest for many research groups to meet the requirement of desired applications. The band gap of CeO_2 nanostructures can be modified by varying the particle size, morphology and dopants. Anchoring the metal oxide nanostructures on graphene sheets will result in composites with improved properties than the parent materials. The presence of graphene sheets will acts a support for the growth, influences the morphology and provides external paths for electronic transitions. Thus, the controllable synthesis of ceria:graphene composites with various morphologies and the understanding of the optical properties is highly important for the usage of these materials in various applications. The development of ceria and ceria:graphene composites with low cost, rapid synthesis with tunable optical properties is still desirable. By this work, we discuss the synthesis of pure ceria (nanospheres) and ceria:graphene composites (nano-rice like morphology) by using commercial microwave oven as a cost effective and environmentally friendly approach. The influence of the graphene on the crystallinity, morphology, band gap and luminescence of the synthesized samples were analyzed. The average crystallite size obtained by using Scherrer formula of the CeO_2 nanostructures showed a decreasing trend with increasing the graphene loading. The higher graphene loaded ceria composite clearly depicted morphology of nano-rice like in shape with the diameter below 10 nm and the length over 50 nm. The presence of graphene and ceria related vibrational modes (100-4000 cm^{-1}) confirmed the successful formation of composites. We observed an increase in band gap (blue shift) with increasing loading amount of graphene. Further, the luminescence related to various F-centers was quenched in the composites. The authors gratefully acknowledge the FONDECYT Project No.: 3160142 and BECA Conicyt National Doctorado2017 No. 21170851 Government of Chile, Santiago, for the financial assistance.

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