

EFFECT of Bi³⁺ CO-DOPING on Yb³⁺ LOCAL STRUCTURE in CeO₂ NANOPARTICLES

**A.K. Ginkel¹, O.A. Morozov^{1,2}, S.L. Korableva¹,
M.S. Pudovkin¹, R.M. Rakhmatullin¹, V.V. Semashko, A.A. Rodionov¹**

¹ Kazan Federal University, Institute of Physics, Kazan, Russia

² Zavoisky Physical-Technical Institute, FRC Kazan Scientific Center of RAS, Kazan, Russia

Cerium dioxide (CeO₂) nanoparticles doped with rare-earth ions are erspective materials for various applications such as catalysis, medicine, bio-imaging, photoenergy, and temperature sensing [1]. The oxygen vacancies play a crucial role in many applications of ceria nanoparticles in the pure and doped form. In this work, we report about EPR and optical study of the CeO₂: 0.1% Yb³⁺ nanoparticles and the CeO₂: 0.1% Yb³⁺ nanoparticles co-doped with 0.5% Bi³⁺ ions, annealed at 600°C and 1000°C. EPR spectra of Yb³⁺ ions show the significant change in the local structure of these ions upon doping with Bi³⁺ and annealing of NPs from 600°C to 1000°C.

The EPR linewidth of the sample co-doped with 0.5% Bi³⁺ is significantly larger as compared with the sample without Bi³⁺ (58 G vs 28 G). This can be explained by more imperfections in the local environment of Yb³⁺ ions introduced by Bi³⁺ ions. The ratio of the cubic centers with g~3.43 of Yb³⁺ ions to trigonal centers with g~3.06 is considerably decreased for the sample co-doped with Bi³⁺ ions. The appearance of the trigonal center with g~2.75 upon annealing of NPs at 1000°C indicates the formation of more oxygen vacancies in the local environment of Yb³⁺ ions in CeO₂ NPs in this sample (Fig. 1 (a)) [2].

Luminescence spectra of Yb³⁺ ions also show significant change upon annealing of NPs from 600°C to 1000°C and revealed increased the intensity in the sample co-doped with Bi³⁺ (Fig. 1 (b)). The luminescence spectra evolution with annealing temperature corresponds to the EPR spectral changes.

In conclusion, co-doping with Bi³⁺ ions leads to the increase of a number of the oxygen vacancies in CeO₂ nanoparticles which improves the functional properties of ceria-based materials.

1. Montini T., Melchionna M., Monai M., Fornasiero P.: Chem. Rev., **116**, 5987–6041 (2016)

2. Abraham M.M., Weeks R.A., Clark G.W., Finch C.B.: Phys. Rev. **148**, 350–352 (1966).

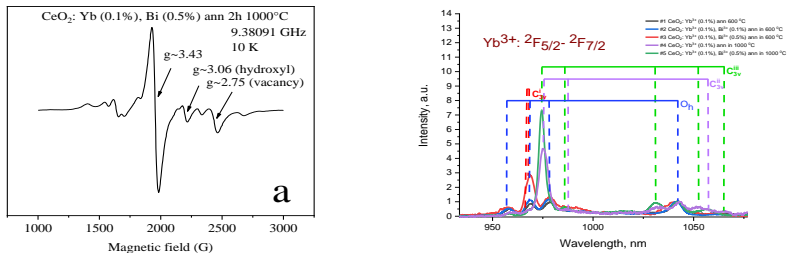


Fig. 1. EPR spectra of CeO₂: 0.1%Yb³⁺ NPs co-doped with 0.5%Bi³⁺ ion; annealed a) 1000°C, b) normalized room-temperature luminescence spectrum of #1 - #5 NPs samples under excitation at λ_{ex} = 350 nm (absorption band CT Ce⁴⁺).