LUMINESCENT AND MICROSCOPY CHARACTERIZATION OF THE GEO_2:EU FILMS DOPED WITH GOLD NANOPARTICLES

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Abstract
The investigated series of films comprise the samples of undoped germanium oxide films, films doped only with gold, films doped only with europium, and the films co-doped with gold and europium. Concentrations of activators were 3% or 5% and 10% for the gold and europium dopants respectively.
The films were deposited by sol-gel method on substrates using centrifugation of film-forming solution prepared from a GeO_2 sol (pH = 8.0, concentration 5 wt %) and aqueous solutions of $HAuCl_4$ and a europium tartrate complex. After drying, these films were annealed in air at different temperatures (T_{ann}). Structure of the films surfaces were studied using the optical microscope (OM) atomic force microscope (AFM). This investigation reveals formation in the films doped with gold of fractal aggregates whose sizes depend on annealing temperature. In particular, sizes of the most of aggregates are small ≤ 30–50 nm for T_{ann} = 800 °C. The films without gold are not characterised by formation of a large amount of aggregates, this is confirm that observed aggregated are the gold nanoparticles (Fig. 1).
Thermal annealing and concentration effects on the spectral-luminescent properties of gel-films based on the GeO_2 co-doped with europium and gold were carried out. The favourable conditions of thermal annealing of the films and concentrations of the co-dopants, which give multiple rise of intensity of the Eu^{3+} ions luminescence, were founded [1]. It has been established that samples of the $87GeO_2–10Eu_2O_3–3Au$ composition annealed at T_{ann} = 800°C show multiple increase of the Eu^{3+} luminescence intensities compared with samples of the $90GeO_2–10Eu_2O_3$ composition.
Study of the excitation spectra and effects of irradiation on spectral-luminescent properties of the filmswere carried out in order to establish whether plasmon resonance of gold nanoparticles are responsible for increasing of the Eu^{3+} emission intensity or no,. Excitation spectra were studied in the maximums of luminescence of the each sample: 615 nm for the films doped with the Eu^{3+} ions, 690 nm for film doped only with gold and 550 nm for the undoped film [2].
We are able to suppose that for all types of emission main excitations take place with participation of processes in the matrix and the gold nanoparticles increase transfer of the excitation energy to emission centers. Various positions of maximum of the long wave length band and its shape also reveal its complex characters and presence of some additional components caused by gold nanoparticles those increase intensity of the Eu^{3+} ions emission.

High resolution thermal imaging of the film's surfaces was made using scanning luminescent procedure developed by Lionel Aigouy in Institut de Physique, Paris, France . Obtained data confirmed mentioned above supposition about structure of the films.

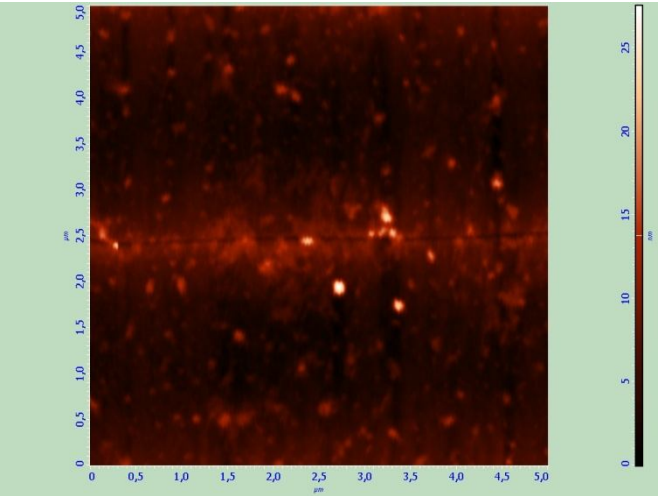

Fig. 1. The AFM (*d*) image of the $87GeO_2–10Eu_2O_3–3Au$ film

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