Investigation of Photoluminescent Properties of *MgO* and *Ga_2O_3* Nanopowders for Gas Sensor Applications

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Introduction

Creating miniature gas sensors with high speed and selectivity low power and price, that can detects the active, in particular, toxic and explosive gases is very important issue especially for highly industrialized regions. Sensors based on metal oxide nanomaterials are currently the most promising to solve this issue due to their reliability, and ease of manufacture and application. The metal oxide nanopowders have a high adsorption ability and reactivity and excellent sensing properties due to their high surface to volume ratio. It means a small change in thickness of the surface dead layer strongly influences the photoluminescence signal and electron distribution in materials. Desorption or adsorption of oxygen ions from the surface of metal oxide nanopowders causes a change in band bending, which results in a reduced dead layer and induces a change in the electron distribution in the nanomaterial. The mixed metal oxides such as Ga_2O_3/MgO with high gas sensitivity and excellent luminescence properties has been of great of interest [1]. The use of mixed oxides can lead to find materials that show improved sensitivity, enhanced adsorption ability, extensive catalytic activity, and high thermodynamic stability.

Methods

The nanopowders were obtained using pulsed laser reactive technology by means of a YAG:Nd^{3+} laser [2]. The XRD and SEM methods were used for structural and morphological characterization of obtained materials. Diffuse reflection spectra were studied on a Shimadzu UV-3600i Plus spectrophotometer. Photoluminescence studies were performed out at room temperature at the installation using a dual monochromator DMR-4. Excitation of photoluminescence was carried out using a UV LED (λ_{max}=365 nm). The test samples were placed in a quartz cell connected to a VUP-5M vacuum unit and a multichannel SNA-2 gas inlet system, which allowed us to conduct photoluminescent studies in different gas environments at a given pressure. Signal registration was carried out using a photomultiplier FEU-27. Spectrum recording and normalization were performed automatically using specially designed software. The spectra obtained were decomposed into Gaussians using the Origin software package.

Results

X-ray diffractometry, scanning and transmission electron microscopy investigation were conducted to determine the structure, shape, and size of the nanoparticles. The X-ray diffraction patterns have peaks characteristic of the hexagonal wurtzite structure, peaks corresponding to other oxides or compounds were not detected. Nanopowders have high optical transmission in the visible and near-IR regions of the spectrum. Fig.1 shows the room temperature photoluminescent spectra of nanopowders with excitation wavelength at 365 nm. For MgO main emission peak located at about 480 nm is can be ascribed to recombination processes resulting from the formation of oxygen vacancy complexes.

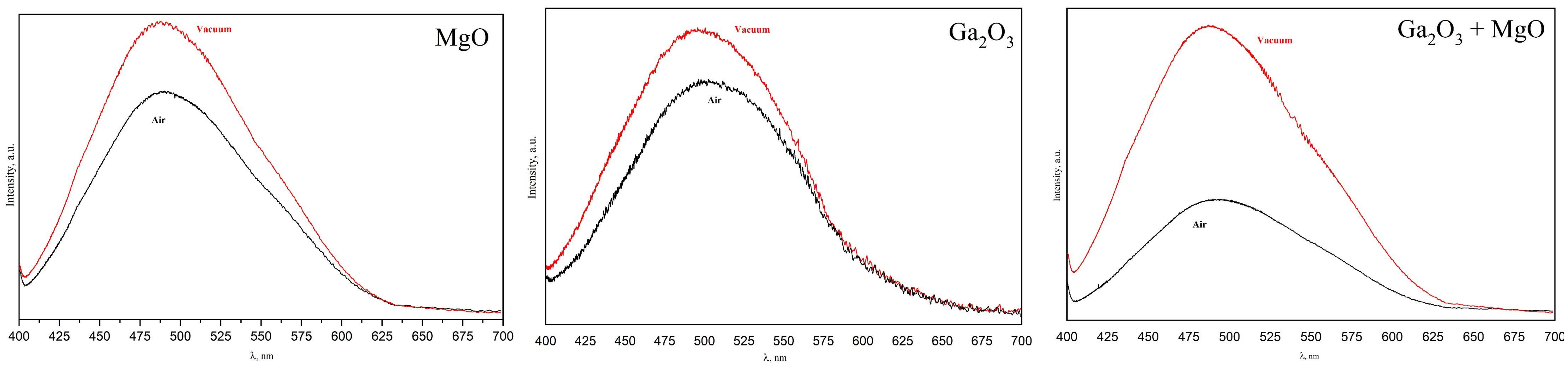

Fig.1. Photoluminescent spectra in air and vacuum (12 Pa) of metal oxide nanopowders

Conclusion

The peculiarities of photoluminescence of MgO, Ga_2O_3 nanopowders and their mix in different ambient Have been studied . Changing the gas environment leads to a significant change in the intensity of the spectra and its deformation for metal oxides, that can be used in the gas sensors. The use of mixed metal oxides (MgO/Ga_2O_3) leads to improve sensitivity, enhanced adsorption ability, extensive catalytic activity, and high thermodynamic stability which is of considerable interest to the gas sensing.

References

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