Spectroscopic and Magnetic Characterization of ZnO:Co Diluted Magnetic Semiconductor Layers Prepared by Printed Electronics Method

Avramenko K.A.[1], Strelchuk V.V.[1], Rarata S.V.[1], Synhaivska O.I.[1], Pekar G.S.[1], Osipyonok M.M.[1], Syngaivsky O.F.[1], Koniakhina M.V.[2], Tronc P.[3]

[1] *V. Lashkaryov Institute of Semiconductor Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine*

[2] *Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*

[3] *Ecole Superieure de Physique et de Chimie Industrielles de la Ville de Paris, Paris, France*

In recent years considerable efforts have been widely made in synthesis of dilute magnetic semiconductors (DMS) that could be used in future spintronic devices which utilize both spin and charge state of carriers. Co-doped ZnO is predicted to belong to such promising DMS, but no one has succeeded in producing ZnO:Co layers that satisfy simultaneously such criteria as desired physical characteristics, high reproducibility and availability of manufacturing techniques. Therefore, the search for new methods for preparation of ZnO:Co with required physical properties still remains an open question.

$Zn_{0,99}Co_{0,01}O$ layers have been synthesized for the first time by a rather simple printed-electronics method developed and patented by the authors. The layers of a high crystalline quality were grown at temperature about 1000°C on (0001)-sapphire substrates.

Magnetic force microscopy measurements of $Zn_{0,99}Co_{0,01}O$ layers showed the non-uniform surface distribution of magnetization revealing room-temperature ferromagnetic behavior of the samples investigated.

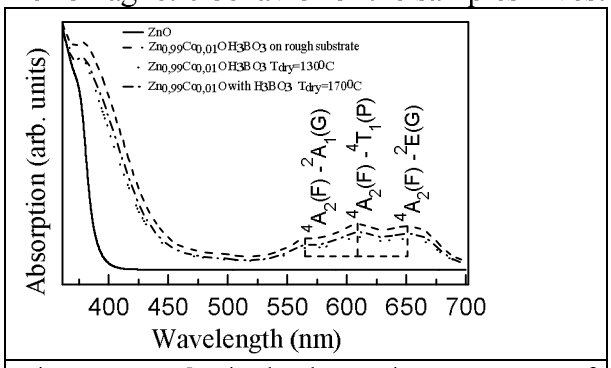

Figure 1. Optical absorption spectra of ZnO and $Zn_{0.99}Co_{0.01}O$ layers prepared under various technological regimes.

The red-shift of the band gap in pure ZnO, as compared with $Zn_{0,99}Co_{0,01}O$ layers, from 387 to 413 nm has been observed in the absorption spectra and is attributed to sp-d exchange interaction between the band electrons and the localized d-electrons of Co ions substituting Zn ions. Observed intra-ion optical absorption at 565, 614 and 654 nm corresponds to the electronic d-d transitions of Co^{2+} ions and confirm the incorporation of Co into the Zn sites of the wurtzite ZnO host lattice.

The observation of the E_2^{low}, E_2^{high}, $E_2^{high} - E_2^{low}$ and A_1^{LO} modes in the Raman spectra confirms that $Zn_{1-x}Co_xO$ layers have hexagonal wurtzite structure. Addition broad vibrational mode in the range 550 to 580 cm^{-1} has been attributed to disordered Zn-O-Co local vibration modes.