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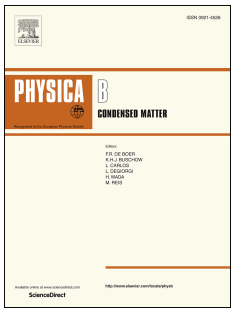

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Effect of Co and O Defects on Ferromagnetism in Co-doped ZnO: An X-ray Absorption Spectroscopic Investigation

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Abstract

Understanding of origin of ferromagnetism in dilute magnetic oxides (DMO's) has become one of the most challenging research problems in condensed matter physics. Here we are reporting a detailed study of magnetic properties and electronic structure of two 5% Co-doped ZnO samples (the as-prepared sample $Zn_{0.95}Co_{0.05}O$ and the hydrogenated sample $Zn_{0.95}Co_{0.05}O$:H). The as-prepared sample is found to be paramagnetic while through hydrogenation, we observed inducement of remarkable ferromagnetism in it. The H-mediated magnetic transition is accompanied by electronic structure modifications with no structural deviations. To get in-depth information into electronic structure correlations of the observed ferromagnetism, we have investigated their electronic properties in detail. For this purpose, we have employed the site-selective and element-sensitive X-ray-absorption spectroscopy (XAS) in the vicinity of the Cobalt $L_{2,3}$ edge, the oxygen *K* edge, and the Zinc L_3 edge using synchrotron radiation. The Co $L_{2,3}$ edge spectra clearly show that Co dopants reside at the Zn sites for both these samples and that they are tetrahedrally coordinated with the ligand O atoms. Very minor changes are observed in the Zn L_3 edge spectra. However, the O *1s* edge spectra display dominant additional components in the ferromagnetic hydrogenated sample $Zn_{0.95}Co_{0.05}O$:H, not observed in the as-prepared non-magnetic sample $Zn_{0.95}Co_{0.05}O$. We conclude that the observed spectral features can be attributed to the presence of O vacancies and the hybridization of Co 3*d* states with O 2*p* vacancy states. These two factors together are likely to play important role in inducement of ferromagnetic ordering in this Co-doped ZnO system. However, which of these two weighs more in this mechanism, cannot be pinpointed and more studies are required in this regard.

Keywords: Dilute Magnetic Semiconductors; Magnetization; Hybridization; Oxygen Vacancies; X-ray Absorption Spectroscopy; Synchrotron Radiation

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