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Co가 치환된 $Zn_{1-x}Co_xO_{1-\delta}$ 묽은 자성 반도체의 전자기적 특성

(Manetic and electric properties of Co-doped $Zn_{1-x}Co_xO_{1-\delta}$diluted magnetic semiconductors.)

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We present a comprehensive investigation on magnetic and electric properties of Co-doped $Zn_{1-x}Co_xO_{1-\delta}$. A series of polycrystalline powder samples $Zn_{1-x}Co_xO_{1-\delta}$ ($x < 0.2$) were synthesized by a the solid-state reaction under variable annealing conditions. From x-ray diffraction analysis, a single wurzite structure, the structure of ZnO, was found to be preserved in all the samples investigated without any impurity phases. With increasing the Co concentration(x), the lattice constant a increases, whereas the lattice constant c decreases systematically. Dc magnetization was measured as functions of temperature and field using a conventional SQUID magnetometer. A systematic doping dependence of magnetic properties was studied by an analysis of the temperature dependence of magnetization using a Curie-Weiss behavior. From the fit of $\chi(T)$ data at high temperatures to the equation: $1/\chi(T)=c/[T+\theta]$, we obtained simple linear relations: $C(x) = C_0x$ with $C_0 = 2.87cm^3K/mol$ and $\theta = \theta_0x$ with $\theta_0 = -612K$. This suggest that the magnetic properties of $Zn_{1-x}Co_xO_{1-\delta}$ can be simply explained by a simple diluted magnetic model with an antiferromagnetic(AF)coupling constant $J = -30K$ between the first nearest neighbors and an effective moment $\mu_{eff} = 4.7\ \mu B$ of Co^{2+}ion spin. The dependence of magnetic properties on carrier concentration was also investigated. The carrier (or oxygen) concentration was controlled by either vacuum annealing or high pressure oxygen annealing. While the electrical conductivity is strongly sensitive to the annealing process or condition, the magnetic properties is found to be negligibly affected. The experimental result demonstrate that the Co-doped $Zn_{1-x}Co_xO_{1-\delta}$ is a simple diluted magnetic system, whereby the carrier, at least n-type carrier, does not play any role in the magnetic properties of the title compound.