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Ferromagnetism enhanced by double exchange interactions in doped ZnO DMS Nanoclusters YOU QIANG, JIJI ANTONY, AMIT SHARMA, DANIEL MEYER, M. FAHEEM, ALAN MCCONNAUGHEY, JAMIE HASS, RYAN SOUZA, University of Idaho — Diluted magnetic semiconductor (DMS) of doped ZnO is of great interest to current research due to its wide variety of applications in spintronics and sensors. We synthesized Ti, V, Co or Ni-doped ZnO nanoclusters using a third generation nanocluster source that utilize a combination of magnetron sputtering and gas-aggregation technique. High-resolution TEM images show that the nanoclusters are monodispersive with a nanocrystalline size < 10 nm. XRD patterns are identical to the bulk ZnO wurtzite structure. XPS detected the dopant elements, which are uniformly distributed in doped nanoclusters. High-resolution XPS showed oxidation states of dopant Ti in +4, and Co in +2 with isovalance, while V in +4 and +5, and Ni in +2 and +3 with mixed valances. These analyses indicate that dopant elements do not exist as independent aggregates but are incorporated into the ZnO structure. All the doped ZnO nanoclusters are ferromagnetic above room temperature. Magnetic moments of Ni and V-doped ZnO ($1.5\mu_B$ or $3.5\mu_B$ per dopant atom) are much larger than Ti or Co doped ZnO clusters ($0.2\mu_B$ or $0.6\mu_B$ per dopant atom). Double exchange interactions due to the mixed valance states are the reason that Ni or V-doped ZnO clusters have much larger magnetic moments than the Ti or Co-doped clusters. Both magnetic and UV optical properties of doped ZnO nanoclusters are dopant concentration dependent.

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