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Confinement-Induced Giant Spin-Orbital-Coupled Magnetic Moment of Co Nanoclusters in TiO2 Films

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High magnetization materials are strongly required for the fabrication of advanced multifunctional magnetic materials and devices, whereas, the development of high magnetization materials is extremely slow. In this work, we propose a new strategy to achieve high magnetization above room temperature by nanoengineering. In detail, 5% Co-TiO2 film has been deposited using pulsed laser deposition. By delicately controlling deposition parameters, Co clusters are formed and further confirmed by transmission electron microscopy, energy dispersive spectroscopy and X-ray absorption near edge spectroscopy. The film exhibits a very high saturation magnetization measured by magnetometer, equivalent to 6.54 ⊠B/Co, given that the magnetic moment is all contributed from Co dopant. However, X-ray magnetic circular dichroism indicates that Co only has a magnetic moment of 3.5 ⊠B. The rest of the moments are contributed from Ti and O. First principles calculations demonstrate that metallic Co nanoclusters embedded in TiO2 matrix can have large both spin and orbital moments, consistent with experimental results. The work indicates that very small nanoclusters under confinement environment can exhibit very large magnetic moments above room temperature, which is promising for designing artificial high magnetization materials.

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