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High-temperature ferromagnetism in Co-implanted TiO2 rutile

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Abstract

We report on structural, magnetic and electronic properties of Co-implanted TiO2(1 0 0) rutile single crystals for different implantation doses. Strong ferromagnetism at room temperature and above is observed in TiO 2 rutile plates after cobalt ion implantation, with magnetic parameters depending on the cobalt implantation dose. While the structural data indicate the presence of metallic cobalt clusters, the multiplet structure of the Co L3 edge in the XAS spectra provides evidence that a sizeable portion of the dopants occupy substitutional Co2+ sites. The detailed analysis of the structural and magnetic properties indicates that there are two magnetic phases in Co-implanted TiO2 plates. One is a ferromagnetic phase due to the formation of long range ferromagnetic ordering between implanted magnetic cobalt ions in the rutile phase, and the second one is a superparamagnetic phase which originates from the formation of metallic cobalt clusters in the implanted region. Using x-ray resonant magnetic scattering, the element specific magnetizations of cobalt, oxygen and titanium in Co-implanted TiO2 single crystals are investigated. Magnetic dichroism was observed at the Co L2,3 edges as well as at the O K edge. Anomalous Hall effect measurement indicates n-type carriers in Co-implanted TiO 2 rutile. The interaction mechanism, which leads to ferromagnetic ordering of substituted cobalt ions in the host matrix, is also discussed. © 2009 IOP Publishing Ltd.

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