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Challenges in the Synthesis of Diluted Magnetic Semiconducting Oxides[1]

THIRUMALAI VENKY VENKATESAN, University of Maryland and Neocera

In the rapidly advancing field of Spintronics, the quest for an above room temperature diluted magnetic semiconductor (DMS) has been thwarted by the lack of a conventional semiconductor with above room temperature ferromagnetism (FM). The recent observation of high temperature FM in numerous oxides has created a flurry of publications with controversial results. I will address the origin of this controversy and trace it to the fact that unlike their predecessors, the manganites, which had significantly large magnetization signals, we are now dealing with samples of weaker magnetization and the measurements are vulnerable to extraneous effects. With the example of Co doped TiO2, I will show that the substitutional incorporation of the magnetic ion in the host lattice is a process dependent phenomenon and Co incorporation and the lattice crystallization have opposing behavior with temperature. The role of TEM-EELS and XAS in distinguishing between intrinsic vs. extrinsic effects will be delineated. There are process regimes in which a homogeneously doped TiO2 DMS system does exist while in the rest of the region one obtains a super paramagnetic system with Co clusters embedded in a TiO2 host. Results from anomalous Hall and field effect studies will be discussed and other magnetically doped oxide host systems will also be covered.

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