Nanoscaled Magnetic Semiconducting Oxides: Remarkable Properties and Potentials for Applications

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About more than 2 decades ago, it was theoretically predicted that ferromagnetism (FM) at room temperature could be obtained in many semiconductors such as ZnO, GaAs, etc if one dopes transition-metals partially into those systems. The magnetic ordering in such compounds was supposed to be governed by the Ruderman – Kittel – Katsuya – Yoshida interaction of localized moments of dopants. Following this direction, many groups had doped transition-metals (TM) into ZnO, TiO_2, SnO_2, etc in order to obtain room temperature FM in semiconductors. Actually, room temperature FM was found, however, the phenomenon is not exactly as theorists have thought of. The finding of FM in pristine HfO_2 thin films of Dublin group in 2004 had suggested the condensed matter physics community to re-verify the actual role that a dopant indeed plays in Diluted Magnetic Semiconducting Oxides (DMSO). Experimental observations of FM for TiO_2, HfO_2, In_2O_3, ZnO, CeO_2, etc in nano-structured forms had confirmed that FM is certainly possible for pristine oxide semiconductors. It seems that FM must come from oxygen vacancies and/or defects that were formed at the surface and interfaces.

Our work on ultra-thin films and nanoparticles of DMSO has proven that downscaling magnetic oxide semiconductors to nanometer-scale should be crucial, in order to make them ferromagnetic. It leads a way to exploit the bright side of nano-materials for spintronic applications.