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INTERFACE INTERACTIONS IN FE3O4-MN3O4 CORE/SHELL NANOPARTICLES

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The coupling between different magnetic layers in thin film systems is usually ferromagnetic (FM i.e. layers parallel to each other). However, other types of couplings such as antiferromagnetic (AFM i.e. antiparallel layers) have also been reported. In contrast, the interface magnetic coupling in bi-magnetic core/shell nanoparticles remains relatively unexplored. While Monte Carlo simulations have probed the effects of different types of interface couplings from the theoretical viewpoint (e.g., FM vs. AFM coupling), experimental work so far has only reported ferromagnetic coupling between the counterparts. Using diverse techniques, here we demonstrate the existence of such interfacial AFM coupling in ferrimagnetic (FiM) soft/hard and hard/soft core/shell nanoparticles, with sharp interfaces and a narrow size distribution, based on iron and manganese oxides, Fe_3O_4-Mn_3O_4. For example, in contrast to conventional systems, the temperature dependence of the magnetization and the ferromagnetic resonance field show a downturn at the magnetic ordering temperature of the hard Mn3O4 phase (TC(Mn_3O_4)=40 K). Moreover, using neutron diffraction and X-ray magnetic circular dichroism experiments, we will show that the strong interface coupling in this system leads to a robust magnetic proximity effect which dramatically enhances the magnetic stability of Mn_3O_4 from the bulk TC of 40 K to above room temperature. Monte Carlo simulations confirm both the AFM interface coupling and the proximity effects. Potential biomedical applications of these effects will be discussed.

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