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Complex magnetic phases and photo-enhanced ferromagnetism in nano-sized core-shell Prussian blue analogue cubes

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Fruitful magnetic behaviors, such as light-induced magnetism, metastable ferrimagnetism, negative magnetization, spin crossover and spin delocalization have been identified in the hexacyanoferrate poly-nuclear complexes known as Prussian blue (PB) and its analogues (PBA). The PBA's are composed of alternately stacked MN_6 and $M'C_6$ octahedra along the three crystallographic axes, where M and M' can be divalent or trivalent transition metal ions. The flexibility to accommodate either divalent or trivalent ions at the M and M' sites has led to a large family of analogues and applications. For example, the structure builds up three-dimensional open channels to accommodate weakly bonded ions able to migrate through the channels and the framework has been exploited as electrode materials for secondary batteries, providing housing for ions to leave the framework during charging and reenter during discharging. In the present studies, different magnetic phases have been identified in nano-sized core/shell PBA cubes, with a 250 nm Rb-Co-Fe phase ($Rb_{0.48}Co[Fe(CN)_6]_{0.75}[(H2O)6]_{0.25}\bullet 0.34H_2O$) in the core coated by a 45 nm K-Ni-Cr phase ($K_{0.36}Ni[Cr(CN)_6]_{0.74}[(H_2O)_6]_{0.26}\bullet 0.11H_2O$) on the shell. Three separate characteristic temperatures at 86, 69, and 67 K are associated with magnetic phases in the K-Ni-Cr shell. Two magnetic exchange paths are identified. One propagates along the three crystallographic axis directions. The other propagates along the [110] crystallographic direction for the associated Ni-Ni interactions, but Cr-Cr interactions. The severe Cr-deficiency and the appearance of direct Ni-Ni exchange are used to understand the appearance of two separate transitions associated with magnetic ordering. A weak moment develops in the core at low temperature, corresponding to separate ordering of the Co-Fe PBA network.

Biography

Wen-Hsien Li is a Full Professor in Physics department at National Central University, Taiwan. He has been the Director since the Center for Neutron Beam Applications of National Central University was found in 2006. He contributed to the birth of Taiwan Neutron Science Society (TWNSS) and Center for Neutron Beam Applications of National Central University. His current research is focused on quantum nanoparticle and multiferroic, using neutron scattering, Raman scattering, and other techniques to elucidate the interplay between the superconducting and magnetic degrees-of-freedom of these systems.

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