CSU PHYSICS COLLOQUIUM

“Magnetic Hardening in Low-Dimensional Ferromagnets ”

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120 Engineering (Hammond Auditorium)

Abstract

How “hard” (coercive) a ferromagnet can be has been a puzzle for a century. Seven decades ago, William Fuller Brown offered his famous theorem to correlate coercivity with the magnetocrystalline anisotropy fields in ferromagnetic materials. However, the experimental coercivity values have been far below the calculated levels given by the theorem, which is called Brown’s Coercivity Paradox. Researchers have attempted to solve the paradox with sustained efforts; however, the paradox remains unsolved, and coercivity still cannot be predicted and calculated quantitatively by modeling.

Progress has been made in the past 20 years in understanding coercivity mechanisms in nanoscale low-dimensional ferromagnets. In fact, ferromagnetism is a size-dependent physical phenomenon, as revealed by theoretical studies. However, nanoscale ferromagnetic samples with controllable size and shape have been available only in recent times. By adopting newly developed salt-matrix annealing, surfactant-assisted milling, and improved hydrothermal and chemical solution techniques, we used a bottom-up approach to produce nanostructured magnets and have successfully synthesized monodisperse ferromagnetic Fe-Pt, Fe-Co and Sm-Co nanoparticles and Co nanowires with extraordinary properties, which are strongly size- and shape-dependent. A study on size-dependent Curie temperature of the L10 ferromagnetic nanoparticles with sizes down to 2 nm has experimentally proved a finite-size effect. A systematic study of nanowires with extremely high coercivity above their magnetocrystalline anisotropy fields has opened a door to the solution of Brown’s Paradox.

Biography

J. Ping Liu received the Ph.D. degree in Physics at the University of Amsterdam, The Netherlands. He is a Distinguished University Professor at the University of Texas at Arlington, USA. For the past four decades he has worked in research and development of permanent magnets and related magnetic materials in China, Europe, and the U.S. His recent research has been focused on hard magnetic nanoparticles, thin films, and bulk nanocomposites, as reported in his more than 320 peer-reviewed journal papers, review articles, and books, including Nanoscale Magnetic Materials and Applications, (Springer, 2009), Skyrmions: Topological Structures, Properties, and Applications (CRC Press, 2016), and Permanent Magnets: The History and Future (Science Press, 2020). He has supervised more than 50 graduate students and postdoctoral researchers. He is an elected Fellow of the American Physical Society and the IEEE. He received the Outstanding Achievement Award at the 25th International Workshop on Rare-Earth and Future Permanent Magnets and Their Applications in 2018.