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Room temperature tunable ferromagnetism in solution grown mesoscopic conjugated polymer rings

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Conventionally, ferromagnetic materials are restricted to metallic regime such as iron and nickel. Although syntheses in the literature have been attempted to induce ferromagnetism in organic polymers, most require sufficiently low temperature, have very low magnetic strength, and no tunability, inhibiting practical applications. This research proposed a novel generalized methodology to create tunable ferromagnetic conjugated organic polymers at room temperature without aid of magnetic metals. Room temperature existence of bipolarons in conductive polymers and the Peierls instability in mesoscopic rings of doped conjugated polymers were hypothesized as rationale for ferromagnetic behavior. Novel one-pot solution based oxidative templating method was employed to form doped mesoscopic conjugated polymer rings/cylinders, evidenced in Atomic Force Microscopy (AFM) and Scanning Electron Microscopy/Energy Dispersive Spectroscopy (SEM/EDS) images. Vibrating Sample Magnetometry (VSM) data for low radii (mean ~39 nm) polyaniline ring demonstrated hysteresis loop like baseline iron nanoparticles, indicating ferromagnetic signature. With increasing ring size (~300 nm) hysteresis loop shrunk and magnetic strength reduced, completely diminishing for larger ring size (~25 μm). Chemical shift from liquid Nuclear Magnetic Resonance (NMR) corroborated VSM data, demonstrating tunability of magnetic strength with varying ring size by controlling oxidative templating. Saturated DC susceptibility from Physical Property Measurement System (PPMS) measurement was averaged to be 0.421 emu/g for low radii polyaniline ring, the highest ever magnetic strength achieved for organic magnets.

Biography

Arnob Das is currently a research student mostly focusing on developing advanced organic magnetic materials. Earlier, he has developed a generalized methodology of inducing paramagnetic behavior in bio-compatible polymeric materials. He also developed a novel synthesis process to generate purely polymeric nanoparticles to detect oxidative stress induced free radicals in human body. He has been recognized nationally and internationally for his research (ISEF- 2015, 2016, 2017). In 2014, as a national level winner of Broadcom Masters, he had the opportunity to meet president Obama at the White House.

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