Tuning the Interaction Potential of Ferromagnetic Cobalt Nanoparticles

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Metallic or magnetic nanoparticles are well known to yield collective physical properties depending on particle size, spacing and high-order structure. Ferromagnetic single-domain particles are of interest to combine with soft matter matrices due to their strong interparticle interaction and high magnetic moment[1,2]. The dipole moment of these materials enables the tailored assembly of superstructures.

The preparation of ferromagnetic cobalt nanoparticles follows the thermolysis of dicobaltoctacarbonyl ($Co_2(CO)_8$) using end-functional polystyrene as a surfactant in the presence of tri-n-octylphosphine oxide (TOPO)[3]. With this method, we can directly influence the size of the cobalt cores by varying the TOPO concentration during the particle synthesis. By careful analysis, we found an unexpected correlation between reaction conditions, core size, magnetic properties, and superstructure observation in TEM experiments. Particles form necklace-like structure of varying length, and also hexagonal and statistically particle assembly is observed.

The results are interpreted in the light of interplay between the attractive dipole-dipole interaction, and repulsive forces, mainly from the polymer shell and surface charge[4]. The superstructures are conveniently influenced and oriented by the application of external magnetic fields.

a) b)

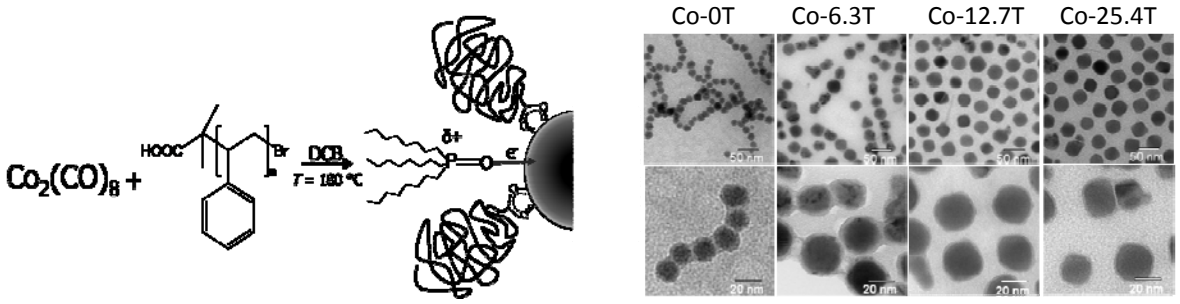

Figure 1: a) Scheme of the preparation of ferromagnetic cobalt nanoparticles in the present of polystyrene and TOPO. b) TEM images of polystyrene-coated cobalt particles with different TOPO content (from left to right: 0 mmol/l, 6.3 mmol/l, 12.7mmol/l and 25.4 mmol/l of TOPO).

This method opens the opportunity to directly tailor the structural and magnetical properties of particulate monolayers, with a potential to result in magnetically stimulable thin films.

References:

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