Synthesis of colloidal $BaTiO_3$ nanoparticles with paramagnetic properties

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In the last couple of decades, the synthesis of ferroelectric perovskites has gained considerable attention due to the wide spectrum of interesting and important applications ranging from electronics and sensors to catalysis and non-linear optics. Barium titanates ($BaTiO_3$), as the most promising and important ones among them, are known from the development of multilayer ceramic capacitors (MLCCs) for smaller size dielectric ceramic powders and positive-temperature-coefficient (PTC) thermistors. Regarding miniaturization in microelectronics, the investigation, development and synthesis of nanosized, monodispersed free-standing $BaTiO_3$ particles with controlled size, well-defined shape, good yields and high degree of compositional homogeneity have become increasingly essential. It can ease investigation of their ferroelectric and magnetic properties at the nanoscale, and can provide the possibility to assemble the nanoparticles into complex 3D nanocrystal structures.

In this study, we show a robust route for the synthesis of $BaTiO_3$ nanoparticles by the hydrothermal method with the use of oleic acid as a surfactant. It allows the preparation of a stable, homogeneous dispersion of the cube-shaped nanoparticles in nonpolar solvents (Figure 1). The synthesised $BaTiO_3$ nanoparticles are studied with respect to their structural, morphological and magnetic properties. They were characterized by DLS, TEM, and SAXS providing information about the microstructure and size. It was found that the nanoparticles are able to assemble either in 1-dimensional linear-like strings or planar 2-dimensional architectures. This process could be accurately tuned by the stabilizer agent concentration. Finally, the ferromagnetic properties of the synthesized $BaTiO_3$ nanocrystals were proved by magnetometry measurements demonstrating the possibility for a multiferroic behavior.

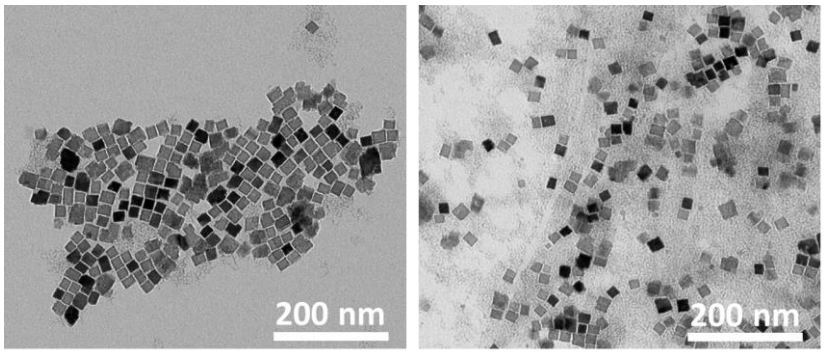

Figure 1. Representative TEM images of the $BaTiO_3$ cubic particles dispersed in toluene with oleic acid as surfactant.