Crystal growth mechanism and ferroelectric domains in $BiFeO_3$ nanoparticles

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Abstract: $BiFeO_3$, as a promising multiferroic material, has attracted strong interest for acoustics, optical, electrical and magnetic study. Here we systematically designed a wet-chemical synthesis process with two optimizing thermal treatment steps to obtain single-phase $BiFeO_3$ nanoparticles via Differential Scanning Calorimetry. The pure phase is confirmed from powder X-ray diffraction. Further, ferroelectric domains in nanoparticles are observed by high resolution transmission electron microscopy, with Fe displacements of 35 pm contributing to the polarization and ferroelectricity in our nano $BiFeO_3$. Through Electron Energy Loss Spectroscopy, a local octahedral ligand environment around Fe^{3+} is confirmed, which character of *R3c* in $BiFeO_3$ nanoparticles. Finally, we thoroughly analysed the growth kinetics via Johnson-Mehl-Avrami thermal kinetic model and deduced that the crystallization mechanism of our nano $BiFeO_3$ is surface nucleation from precursor powders. Our findings therefore furnish a practical method for synthesizing high quality nano $BiFeO_3$ and highlight the ferroelectricity in $BiFeO_3$ nanoparticles which rely on the interface coupling.