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Survival of Verwey transition in gadolinium-doped ultrasmall magnetite nanoparticles†

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We have demonstrated that the Verwey transition, which is highly sensitive to impurities, survives in anisotropic Gd-doped magnetite nanoparticles. Transmission electron microscopy analysis shows that the nanoparticles are uniformly distributed. X-ray photoelectron spectroscopy and EDS mapping analysis confirm Gd-doping on the nanoparticles. The Verwey transition of the Gd-doped magnetite nanoparticles is robust and the temperature dependence of the magnetic moment (zero field cooling and field cooling) shows the same behaviour as that of the Verwey transition in bulk magnetite, at a lower transition temperature (~110 K). In addition, irregularly shaped nanoparticles do not show the Verwey transition whereas square-shaped nanoparticles show the transition. Mössbauer spectral analysis shows that the slope of the magnetic hyperfine field and the electric quadrupole splitting change at the same temperature, meaning that the Verwey transition occurs at ~110 K. These results would provide new insights into understanding the Verwey transition in nano-sized materials.

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