



Tweaking Nanoscale Functionalities by Correlated Disorder

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ABSTRACT

The quest for nanoscale crystals that surpass the performance of a single core is motivated by the design-concept of controlling the spatial distribution of chemical composition within a single motif. In that respect, colloidal nanocrystals (NCs) designed for important biomedical applications [1], such as magnetic hyperthermia treatment of tumors, occasionally require defect-free, large entities (>20 nm) due to their high capacity to dissipate heat in their near vicinity.

Disorder though, is an inherent component of real nanoscale materials, with significant implications for their application in functional devices. Here, we discuss the evolution of size and shape mediated structural disorder in core-shell iron-oxide NCs and learn how their imperfections couple to properties relevant to nanobiotechnology [2]. In this endeavor, especially valuable are NCs with subcritical sizes (<20 nm), which occasionally display the desired magnetic properties and some other times they don't, making it rather challenging to comprehend their diverse responsiveness. X-ray total scattering methods, utilizing ultra-bright, high-energy photons offered at a synchrotron facility, attest that their differences arise primarily due to metal cations missing from particular lattice sites. The emerging local symmetry breaking owing to correlated defects, changes the nanocrystal's magnetic anisotropy. In effect, the emerging competition amongst the elementary magnets (spins) out of which the NCs are composed, allows a remarkable magnetically mediated heating power generation for potential hyperthermia and related theranostic applications [3].

The investigations advocate the broader implications of atomic-scale defects, but also enquire how prevalent correlated disorder effects, combined with alternative pathways to remedy the atomic-scale defects, may drive interactions and enable optimized nanomaterials functionality.

REFERENCES

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