Maghemite nanoclusters: A promising multifunctional material for biomedicine

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Researchers' efforts have been stimulated by the use of nanocrystals (NCs) as multifunctional vehicles for diagnosis (MRI contrast agents) and therapy (targeted drug delivery or/and hyperthermia treatment). The designing of these vehicles named "theranostic agents", takes into account the physical, chemical properties as well as the contingent interactions with the human environment.

We present an iron oxide-based system, which is an assembly of maghemite NCs giving rise to water-dispersible colloidal nanoclusters (CNCs) (Fig. 1a). The high-temperature synthesis has the advantages of size-controlling, good stability and cost-efficiency. The system is ferrimagnetic (Mössbauer spectroscopy) due to the clustering process and the associated interplay of the dipolar interactions among the composing NCs and the intra-particle exchange interactions (SQUID magnetometry & Monte Carlo Simulations) [1].

The potentiality of the CNCs is demonstrated by relaxometric studies which revealed CNCs' 4-times enhanced transverse ^{1}H-NMR relaxivity against that of superparamagnetic (SPM) contrast agents, like Endorem®, (r_2; Fig. 1b) [2]. CNCs' thermal response in hyperthermia (Specific Loss Power; Fig. 1b inset) compared against the individual SPM NCs, points the role of ferrimagnetism and the corresponding intra-cluster interactions to generate an additional heating response mechanism (hysteresis losses). Preliminary incubation experiments with mice spleen cells indicate CNCs' low cytotoxicity and biocompatibility (Fig. 1c). The tailored physical properties render the CNCs a multifunctional material, which is likely to serve as a modular theranostic agent.

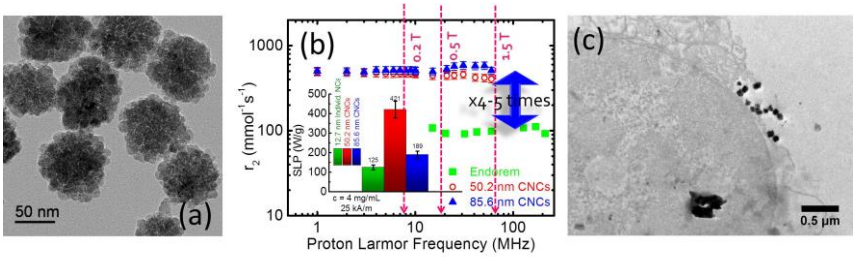

Figure 1: (a) TEM image of nanoclusters. (b) relaxivity (r_2) and specific-loss power (SLP) (as inset). (c) TEM after the incubation of CNCs with mice spleen cells.

References

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