Mastering Contrast Agents in a Single Structure for T_1-T_2 Dual Magnetic Resonance Imaging

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Introduction. Signal Intensity (SI) in Magnetic resonance imaging (MRI) depends on longitudinal (T_1) and transversal (T_2) relaxivity times.[1] Unfortunately, the intrinsic contrast changes associated to a pathologic condition are often too limited for accurate diagnosis. Here, MRI contrast agents (CA) improve image resolution based on their selective accumulation in the Region Of Interest.[2] These CAs are classified as positive (T_1-weighted) or negative (T_2-weighted) image contrast promoters. The acquisition of MRI weighted in T_1 and T_2 could improve the safety of diagnosis.[3] In this context, it has been reported that Prussian Blue (PB) derivatives with general molecular formula $K_xGd_{1-x}(H_2O)_n[Fe(CN)_6]$ and nanosized crystallites present high performance as dual T_1-T_2 CAs.[4] Unfortunately, their clinical use is precluded by the partial solubility in physiological medium. In this work, to protect $Gd(H_2O)_4[Fe(CN)_6]$ nanoparticles we have coated them with a thin amorphous silica shell by polymerizing the silicate at neutral pH, obtaining an stable CA for *in vivo* MRI.

Results and Discussion. The combination of Gd and Fe magnetic centers closely packed at the same crystalline structure leads to a magnetic synergistic effect, which results in an outstanding improvement of longitudinal relaxivity with regards to soluble Gd^{3+} chelates, whilst keeping the high transversal relaxivity inherent to iron oxide nanoparticles. This CA improves positive and negative contrast in T_1- and T_2-weighted MR images, both in *in vitro* and *in vivo* systems. Furthermore, this novel hybrid presents a high biosafety profile and has strong ability to incorporate organic molecules on surface, displaying great potential for further clinical application.

Conclusion. With regards other proposed T_1-T_2 dual mode CAs, these nanoparticles present very homogeneous composition and constant Gd:Fe atomic ratio, providing reproducible quality in MRI signal.

References

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Figures

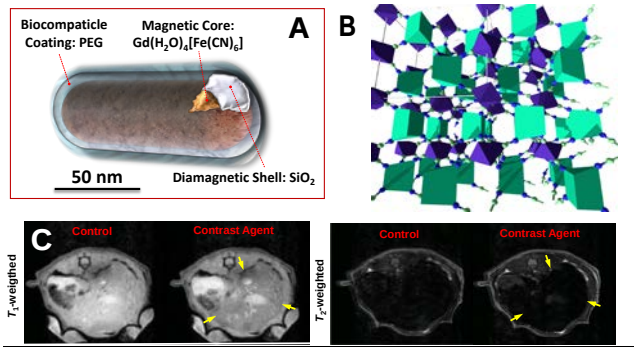

Figure 1: (A) Artistic representation of Gd-PB nanoparticle protected with a silica shell. (B) Network topology of $Gd(H_2O)_4[Fe(CN)_6]$. (C) *In vivo* coronal T_1- and T_2-weighted images acquired from a male Sprague-Dawley rat at 7 T magnetic field.