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Towards Targeted *In-Vivo* Theranostics with Magnetic Nanostructures

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Abstract – Magnetic nanostructures are rapidly emerging as a potential broad platform for combined targeted diagnostic and therapeutics (theranostics) for addressing localized diseases such as cancer tumors. This results from high T2 relaxivity of magnetic oxides, which can be synthesized with exquisite control over composition, size and shape. Further, application of external RF field to the magnetic nanostructures results in enthalpic contribution with predictable increase in local temperature for therapeutic effect. The progress in this field will be presented in the context of optimization and engineering approach to targeted theranostics for cancer and Amyloid-based diseases.

Nanostructures of complex oxides (spinels) are utilized for designing broadly deployable platform[1] for unified and combined non-invasive imaging, diagnostics and therapeutics – termed "*Targeted Theranostics*". In particular, magnetic nanostructures[2-3] with tunable magnetic properties coupled with anisotropic nanoscale morphologies functionalized with receptors/antibodies for targeting cancer tumors (Central Nervous System (CNS) cancers such as medulloblastoma) and Amyloid proteins responsible by diseases such as Alzheimer's. The localized of magnetic nanostructures at targeted sites is monitored by their innate high T2 contrast in magnetic resonance imaging (MRI). Non-invasive external RF field is used to thermally activate the targeted nanostructures, resulting killing of cancer cells and fragmentation of Amyloid proteins assembly. Fig. 1 shows high relaxivity of nanostructured magnetic spinels (commercial ferumoxytol reference), while Fig. 2 indicates selective targeting of medulloblastoma cells with two different receptors (TGF-β(r)) and (NCAM-1). The nucleus is stained with DAPI (blue), and targeting with two surface receptors are seen with green/red fluorescence. The subsequent *in-vitro* studies show that it is possible to observe the localization via MRI and thermal activation by RF field. Appropriate animal models have been developed, and *in-vivo* studies are underway. The presentation will cover optimization and engineering approach to such targeted theranostic platform.

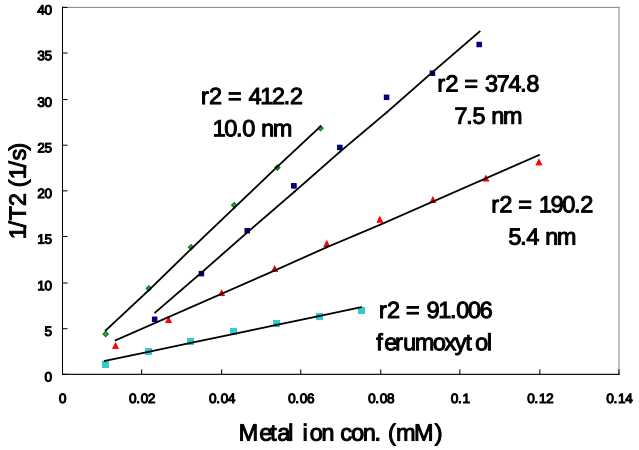

Fig. 1: Magnetic relaxivity plots for spinel magnetic spinel oxides as a function of size. Commercial ferumoxytol is used as a reference.

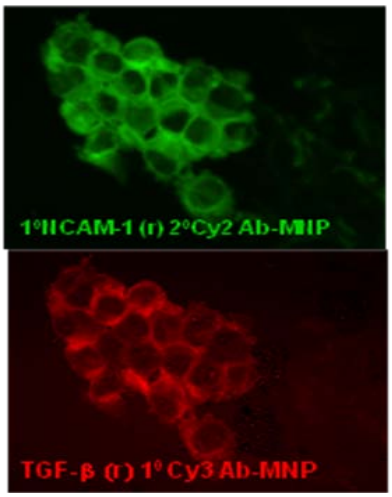

Fig. 2: Medulloblastoma cells simultaneously targeted with receptors for TGF-β(r) (red) and NCAM-1 (green).

References

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