**Gadolinium Doped Gold-Speckled Nanoparticles for Multimodal Imaging**

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**Introduction**

Clinically used imaging modalities such as Computed Tomography, Magnetic Resonance Imaging (MRI), Ultrasound etc. do not provide complete structural and functional information independently. It is thus advantageous to obtain information from complimentary imaging modalities to facilitate diagnosis. This has lead to the development of multimodal contrast agents, which can generate contrast simultaneously from desired imaging modalities [1]. Herein, we describe the synthesis, characterization and functional evaluation of a new class of gold-silica hybrid nanoparticles termed as gold speckled silica (GSS) nanoparticles. The multitude of dielectric-metal interfaces created by this method gives rise to unique photothermal properties that enable the use of these materials as contrast agents in photo acoustic tomography (PAT). Furthermore, the incorporation of gadolinium (Gd) into the silica matrix produces a multimodal GSS contrast agent for both magnetic resonance (MR) and photo acoustic tomography based imaging. These multimodal particles are a novel step forward towards integrating multimodal detection and therapeutic capabilities into a single entity.

**Experimental**

The one pot, microemulsion mediated synthesis and characterization of Gd doped GSS nanoparticles has recently been published in detail elsewhere [2]. The dual imaging capabilities of these particles has been demonstrated using phantoms and in vitro studies. The MR data (T₁, T₂ and T₂*) was collected using a 4.7 T Bruker Avance MR scanner (AMRIS facility, UF). Relaxivity measurements were carried out in glass micropipettes filled with ~200 μL of serially diluted GSS nanoparticles (in 0.5% agarose) using 0.5% agarose as control. PAT measurements were made using a mechanical scanning photoacoustic system with single acoustic transducer using a pulsed Nd:YAG laser working at 532 nm with 4 ns pulse duration, 10 Hz repetition rate. The dual contrast generating ability of the GSS nanoparticles was demonstrated by injecting them in phantom (prepared using Intralipid, India ink, distilled water, and 2% agar powder) and consecutively imaging by MRI and PAT.

**Results and Discussion**

TEM of GSS nanoparticles [Figure 1(B)] shows the surface layer of these nanoparticles is composed of discontinuous, irregular gold nanodomains of varying crystallinity incorporated within the supporting silica matrix. Figure 1(A) and (C) show the PAT and MRI (T₁) contrast from the same phantom containing 1, 3, and 5 μL (particle concentration, 10 mg/mL) of Gd-doped GSS nanoparticles. The relaxivities R₁, R₂, and R₂* have been determined to be 13, 110, and 173 mM⁻¹ s⁻¹, respectively, which is much higher than commercially available contrast agents [2].

**Conclusions**

Gd doped GSS have been demonstrated as single nanoparticle contrast agent for non-invasive imaging by PAT and MRI. The optical absorption property of these particles also enables their use for photothermal applications.

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**References**