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Characterization of Gold Nanocages as Contrast Agents for Optoacoustic Imaging

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Optoacoustic (OA) imaging is being investigated as a non-invasive technique for monitoring cancer therapeutics. It involves exposing tissues to nanosecond pulsed near infrared laser light. The optical energy is absorbed by tissue chromophores and converted into heat, leading to thermoelastic expansion, producing acoustic waves in the ultrasonic frequency range which are then detected by transducers. Gold nanocages (AuNCs) are plasmonic particles that are highly absorbing in the near infrared, are biocompatible and their surface chemistry can be functionalized to target specific cells. Hence there is great interest in the capability of AuNCs to enhance OA image contrast at depth. Yet there remains concern about the potential damage to the AuNC structure as a result of pulsed laser exposure.

In this work, the stability of AuNCs following pulsed laser exposure was evaluated using absorption spectroscopy and transmission electron microscopy (TEM) imaging. Gold nanocage solutions, of varying concentration, were irradiated by laser pulses for 1 to 5 minutes using a reverse-mode optoacoustic imaging system (Seno Medical, San Antonio, TX). For direct illumination at 775 nm, the AuNCs demonstrated conformational changes including melting (pulse energy of 10 mJ) and fragmentation (pulse energy of 21 mJ) which led to a change in surface plasmon resonance. Optical absorption data demonstrated an 82.9 nm blue shift and 66.7 % decrease in peak amplitude following a 5 min exposure at 10 mJ. However, AuNC targets of varying particle concentrations placed in tissue mimicking phantom materials of varying background optical absorption (up to 4.0 cm-1) exhibited no damage following OA exposure, while improving image contrast by up to 300 %. This study demonstrates the utility of gold nanocages as contract agents for optoacoustics.

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