Optimization of Hollow Gold Nanoparticles for Photothermal Ablation of Cancer

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A developing cancer treatment is photothermal ablation therapy (PTA), which uses the conversion of light to heat to kill cancer cells. Gold nanoparticles support surface plasmons, or waves of conducting electrons at the surface of a metal, that can absorb and focus light for better photothermal conversion. The aim of this project was to study the effect of the size, shape, and shell thickness of hollow gold nanoparticles (HGNs) on their ability to focus near infrared light. Using finite-difference time-doman simulations, average electric field intensities were calculated for HGNs with varying dimensions. Radii between 16 nm and 50 nm and shell thicknesses between 2 nm and 6 nm were studied. Results were compared to those of a spherical control particle (22 nm radius with a 4 nm gold shell) that was the focus of a previous experimental study by Zhang as described in the Journal of Physical Chemistry Letters. A spherical HGN with a 28 nm radius and 3 nm gold shell produced an average electric field intensity 23 times greater than the control particle. In an attempt to improve the results, ellipsoidal HGNs were studied by varying the aspect ratio (1.25, 1.5, 1.75 and 2.0). Analysis revealed that a 36 nm HGN with an aspect ratio of 2.0 and 4 nm gold shell resulted in the highest average electric field intensities, which was 27 times greater than the control. All calculations were performed on a computing cluster at a local Florida college.