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P2.3015 laser-driven synthesis of nanoparticles for therapeutic applications

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Gold nanoparticles (GNP) have a wide range of applications in medicine, such as a radiosensitiser in radiotherapy[1], GNP coated single walled carbon nanotubes (SWCNT), to be used as a photothermal agent[2], targeted drug delivery systems, and other forms of cancer treatment and diagnostics[3]. Research into GNP production focuses on quality factors; such as size distribution, shape and purity, versus the cost of production. Mainstream synthesis of GNP, such as wet chemistry, has its main challenges due to impurities in the process. Laser ablation in liquids (LAL) offers an alternative method of a cheaper and quicker production of ultra-pure NP solutions and the reduced material heating with ultra-fast lasers allow NPs with narrower size distribution, and better controllability in shape and size compared to other methods[4][5]. In a preliminary experiment, a 99.95% purity gold disc of 4mm diameter, 0.1mm thick, submerged in a few mm of DI water. A 337fs pulsed laser of wavelength 1040 nm was focussed onto the surface of the gold producing a fluence of 6J/cm2, ablating individual sites over 2.6mm x 2.6mm square on the gold. Two samples were prepared using exposure times of 1s and 0.5s for each site, producing solutions of a dark red and a light red/pink colour, respectively. Characterisation via UV-Vis Spectroscopy gave diameters of 40nm in the 1s exposure sample and to 15nm in the 0.5s sample, with the difference most likely due to material heating with the longer exposure time. In another experiment, the craters produced in water and in air with varying laser power (20-100%) investigated via SEM can relate the laser intensities between water and air, with the heated affected area of the craters ranging from 40-90μm. The craters produced in air were larger than in water, indicating a reduction in intensity possibly due to water affecting the focus. For future experiments, The NP size dependency on laser fluence, crater investigations and retrospective imaging of the ablation process.

[1] Jain (et al), Oncology Biology Physics, Vol. 79, Pgs: 531539, Year: 2011. [2] Meng (et al), Applied Materials Interfaces, Vol. 6, no.7, Year: 2014. [3] Ling (et al), Nanotoday, Vol. 9, no. 4, Year: 2014. [4] Kabashin (et al), Journal of Applied Physics, Vol. 94, Pgs: 7941-7943, Year: 2003. [5] Gamaly (et al), Physics Reports, Vol. 508, Pgs: 91-243, Year: 2011

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