Synthesis mechanisms and cytoxicity evaluation of Au nanoparticles densely coated nanographene oxide for biomedical applications

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Nano-graphene Oxide (NGO) and colloidal Au nanoparticles (NPs) are attractive materials for biomedical purposes thanks to their high degree of dispersibility in aqueous media and peculiar optical and electronic properties. Indeed, NGO shows optical absorption in the NIR and high surface area, both relevant for diagnostic or therapeutic applications[1]. Au NPs are characterized by Localized Surface Plasmon Resonance (LSPR) absorption in the Vis and NIR and a prompt surface functionalization with targeting ligands, drugs or contrast agents[2]. The immobilization of Au NPs onto NGO surface results in multifunctional hybrid nanoplatforms, attractive for biomedicine, due to the combination of the interesting properties of the pristine components resulting in enhanced functionalities[3]. The typical synthetic route relays on a sustainable colloidal *in situ* approach starting from reduction of the $HAuCl_4 \cdot 3H_2O$ precursor onto the oxygen functionalities of the NGO flakes by trisodium citrate ($C_6H_5O_7Na_3$). However, the synthetic mechanism has not been elucidated so far, and the achieved nanostructures show a poor control of the Au NPs morphology and a low coating density of the flakes[3], thus limiting the potential for applications. This work aims to overcome these issues, performing an *in situ* synthesis of the Au NPs onto NGO sheets converting pristine epoxy and -OH groups into -COOH functionalities by Williamson reaction, as effective coordinating sites for the NPs growth. The reaction mechanism has been studied by investigating the effect of NGO:Au w/w, $HAuCl_4$ $3H_2O$:$C_6H_5O_7Na_3$ molar ratio, reaction temperature, pH and reactants injection sequence. The functionalization with polyethylene glycol (PEG), aiming at reducing immunogenicity, exploiting its stealth properties[4], has been performed, and optimized tuning the NGO:PEG w/w. PEG coated NGO/Au NPs structures, highly stable in water, densely coated with Au NPs, and exhibiting an intense absorption peak at 533 nm, have been achieved with a reproducible control of the NPs geometry and size distribution. An *in vitro* study on the cell viability of the nanostructures has been performed by MTS assay on normal epithelial HCEC-1CT and metastatic gastric cancer N-87 cell lines, as a function of exposure time and nanostructures concentration. The results show that the novel NGO/Au NPs-PEG hybrid nanoplatforms are promising candidate for biomedical applications, with a relevant potential for use in imaging, drug delivery and photothermal therapy.

References

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