Inorganic-Organic-Biological Hybrid Nanocomposite for Multifunctional Biomedical Engineering

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In this research, we present the multi-nanomedicinal functions of a hybrid nanocomposite integrating metal oxide (CuxFe3-xO4, CFO) nanoparticles (NPs), biological bovine serum albumin (BSA) coatings and surface-loaded organic photosensitizer IR780 dye. The optical and morphological characterizations of the as-prepared nanocomposite (denoted as CFO@BSA-IR780) are investigated using TEM, DLS and UV-Visible spectroscopy. The presence of Cu2+ and Fe3+ ions in CuxFe3-xO4 NPs enables peroxidase-like activity, and it is confirmed by chemodynamic assay in which CuxFe3-xO4 NPs produce hydroxyl radicals (•OH) in the presence of hydrogen peroxide (H2O2). Moreover, Cu2+ promotes glutathione (GSH) depletion to form oxidized GSH (GSSG), preventing the interference of GSH and thus enhance the chemodynamic effect. On the other hand, the photodynamic and photothermal performances from loaded IR780 dye are examined using 808 nm laser light, resulting in generation of reactive oxygen species and good photothermal conversion efficiency, respectively. Successfully prepared CFO@BSA-IR780 multifunctional nanocomposite shows better biocompatibility. In the presence of laser irradiation and H2O2 supply, CFO@BSA-IR780 eliminates cancer cell death within 24 hours due to the synergistic chemodynamic, photodynamic and photothermal effects. Besides the therapeutic potentials, Uptaking CFO@BSA-IR780 can be confirmed by the fluorescence image and MRI, showing the diagnosis potential of the nanocomposite. In general, CFO@BSA-IR780 nanocomposite developed in this study demonstrated combined therapeutic and bioimage potential. Therefore, it is a promising candidate for future nanomedicine.

Awards Won:

American Chemical Society: First Award of $4,000