Fabrication of Fluorescence Graphene Quantum Dots/CoFe2O4@SiO2 Nanoparticles and Potential Application for Targeted Drug Delivery and Fluorescence Imaging of Cancer Cells

Wednesday, 3rd October @ 13:30: Poster Session (HALL & ROOM 3) - Poster - Abstract ID: 401

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Introduction

Researchers are placing much efforts on the nanocomposites with physiochemical properties. Graphene quantum dots (GQDs) have attracted remarkable interest in drug delivery and biosensing attributed to their tunable photoluminescence and great biocompatibility[1]. Moreover, inverse spinel cobalt ferrite ($CoFe_2O_4$) is gaining significant attention due to its moderate saturation magnetization and great chemical-stability[2]. The $CoFe_2O_4$ nanoparticles present promising potential in biomedical application, especially in targeted drug delivery that can alleviate the side effects of conventional chemotherapy by reducing the systemic distribution of drugs. However, there are no reports of GQDs/$CoFe_2O_4$ based nanocomposites for targeted drug delivery and fluorescence imaging of cancer cells.

Methods

In this work, we fabricated the novel GQD/$CoFe_2O_4$@SiO_2-FA nanoparticles and investigated their potential application as the fluorescence nanoprobe for the tumor-targeted drug delivery. GQDs were synthesized by the carbonization of citric acid (CA). The $CoFe_2O_4$ were synthesized via thermodecomposition. The surface modification of $CoFe_2O_4$ nanoparticles with silica and amine group enabled the covalent bonding with GQDs. Then the attached FA led to the tumor-targeted delivery and intracellular release of anticancer drug DOX in Hela cells (Fig.1).

Results and discussion

We show that the resulting $CoFe_2O_4$ nanoparticles possessed an average size of 15.3±1.7 nm (Fig.2a). The spherical GQDs with the average size of 3 nm exhibited blue fluorescence under 365nm UV light and no fluorescence in bright filed compared with blank solvent (Fig.2b-2d), indicating the rendered blue fluorescence property of the fabricated GQDs. The drug loading capacity onto GQD/$CoFe_2O_4$@SiO_2-FA was explored. The qualitative and quantitative analyses of cellular drug release in vitro and the fluorescence imaging of living Hela cells were performed. The biocompatibility of fabricated GQD/$CoFe_2O_4$@SiO_2 nanoparticles was confirmed with cytotoxicity assessment.

Conclusion

We fabricated the fluorescence GQD/$CoFe_2O_4$@SiO_2-FA nanoparticles and explored the potential application for targeted drug delivery and fluorescence imaging of cancer cells. These GQD@$CoFe_2O_4$ based nanocomposite could be a promising platform for cancer therapy, leading to further developments of intelligent anticancer drug carrier.

Reference

1. Y. Li et. al, Adv. Mater. 23, 776-780 (2011).

2. Urs. Häfeli et. al, Springer, (2013).

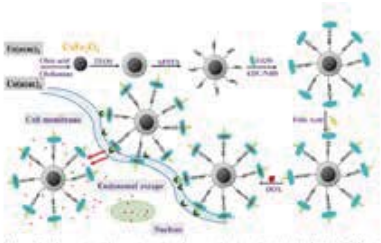

Fig. 1 Schematic illustration for the synthesis of GQD/$CoFe_2O_4$@SiO_2 nanoparticles and working protocol for targeted drug delivery.

Fig.1.png

Fig. 2 (a) TEM image of $CoFe_2O_4$ nanoparticles, (b) TEM image of GQDs, (c) Bright field optical image and (d) 365nm UV light optical image of GQDs (right) and blank solvent (left).

Fig.2.png