Fluorescence Magnetic Immunoassays Using Graphene Quantum Dots and Fe2O3@SiO2 Composite for AFP Detection

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Introduction

Alpha-fetoprotein (AFP) is a single polypeptide chain glycoprotein, and high AFP levels are found in some typical cancer tumors such as the cancer tumors in ovaries, stomach, pancreas or liver[1]. Therefore, AFP can be used as a biomarker to detect cancer cells. However, due to the time-consuming, low sensitivity and complex operation in conventional methods for AFP detection, the effective and simple technology is still in dire need. The silica-coated iron oxide nanoparticles (NPs) hold much promise for targeted drug delivery and bio-separation. Furthermore, graphene quantum dots (GQDs) with novel photoproperties are wildly used in biomedical diagnosis[2]. Motivated by these advantages, we report a novel strategy of fluoro-magnetic immunoassay based on GQDs and Fe_2O_3@SiO_2 for AFP detection.

Methods

GQDs were fabricated by citric acid pyrolysis method, and AFP antibody Ab1 was covalently conjugated on GQDs with fluorescence labelling (Fig.1A). The spherical Fe_2O_3 NPs were prepared through a modified thermal decomposition method and modified with silica and the carboxylic group, which induced the covalent connection with the capture antibody Ab2 (Fig.1B). The AFP detection was performed in two steps that the AFP antigen was initially incubated with Ab2/Fe_2O_3@SiO_2NPs. Then the Ab1/GQD were added to form a sandwich immunocomplex separated by the magnet (Fig.1C). Finally, the obtained immunocomplex was determined with fluorescence signal.

Results and discussion

We show that the as-prepared GQDs presented good dispersion in water solution with the size of 3±0.4 nm (Fig.2a), and these GQDs with blue fluorescence exhibited an absorption peak at 358 nm (Fig.2b). The Fe_2O_3@SiO_2 NPs were with 10 nm core diameter and 9 nm shell thickness (Fig.2c). The silica shell not only prevented particle aggregation but also avoided the possible fluorescence quenching effect by the Fe_2O_3 cores. The concentration of AFP was quantified by the fluorescence intensity of Ab1/GQD-AFP-Ab2/Fe_2O_3@SiO_2 sandwich immunocomplex.

Conclusion

We developed a simple and accurate immunoassays strategy based on fluorescence magnetic sandwich structure Ab1/GQD-AFP-Ab2/Fe_2O_3@SiO_2 immunocomplex for AFP detection. It can be an available platform for medical diagnosis and fluoroimmunoassay device application.

References

1. E. Waidely. et al., Analyst. 141, 36–44 (2016).

2. Y. Zhang et al., Theranostics. 2, 631 (2012).

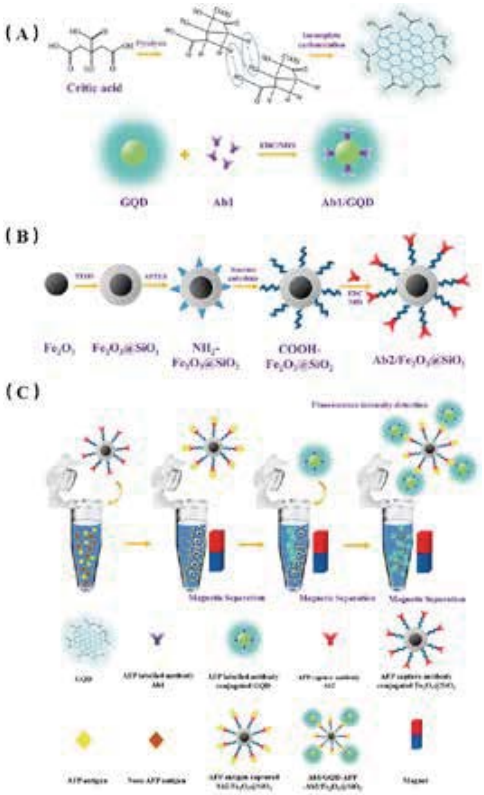

Fig. 1 Schematic illustration of the fabrication process of (A) GQDs and conjugate with AFP antibody Ab1, (B) $Fe_3O_4@SiO_2$ nanoparticles and conjugate with AFP antigen, and (C) Experimental procedure of fluoro-magnetic immunoassay based on using Ab1/GQD and Ab2/$Fe_3O_4@SiO_2$ NPs for AFP detection.

Fig.1.png

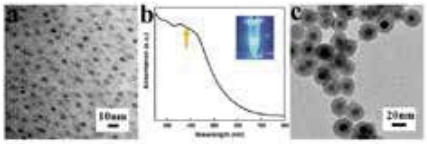

Fig. 2 (a) TEM image and (b) UV-Vis absorption of GQDs, and (c) TEM image of $Fe_3O_4@SiO_2$ nanoparticles.

Fig.2.png