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CdS nanocrystals/graphene oxide-AuNPs based electrochemiluminescence immunosensor in sensitive quantification of a cancer biomarker: p53

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ABSTRACT

An ultrahigh sensitive, simple and reliable Electrochemiluminescence (ECL) immunosensor for selective quantification of p53 protein was designed according to the enhancement effects of AuNPs on ECL emission of CdS nanocrystals (CdS NCs). CdS NCs were immobilized on the glassy carbon electrode and AuNPs introduced to the process through formation of a sandwich-type immunocomplex between first anti-p53/p53/ secondary anti-p53. ECL of CdS NCs firstly evoked the SPR of AuNPs which in return amplified the CdS NCs ECL intensity. By using graphene oxide in immunosensor fabrication procedure, and attaching more AuNPs on the surface of the electrode, the ECL intensity was further increased resulting in much higher sensitivity. After applying the optimum conditions, the linear range of the developed immunosensor was found between 20 and 1000 fg/ml with a calculated limit of detection of 4 fg/ml. Moreover, the interference, reproducibility and storage stability studies of the immunosensor were investigated. Finally, immunosensor's authenticity was evaluated by detecting the p53 protein in human spikes which offers it as a potential in early detection of cancer, monitoring the cancer progress and clinical prognosis.

1. Introduction

Since protein biomarkers have been on the focus of the researchers in recent decades, there is an increasing demand for highly sensitive detection of these biomarkers. Development of new drugs, diagnosis of different kinds of diseases which could help monitoring cancer treatments (Doustvandi et al., 2017; Navaeipour et al., 2016), Immunology and other medical applications are greatly dependent on quantification of protein biomarkers (Afsharan et al., 2016a; Hasanzadeh et al., 2017). In particular, early cancer prognosis and sickness monitoring showed indisputable dependence to cancer biomarkers. p53 protein, a widely known tumor suppressor gene and a prominent cancer biomarker, plays inevitable role in cell proliferation and specially in apoptosis. It prevents genome mutation and thus, a failure in its functionality leads to highly risks of cancer (Afsharan et al., 2016c). From this point of view, finding sensitive, reliable and low-cost methods for detection of p53 protein seems very desirable and has drawn a lot of attention in recent years (Hasanzadeh et al.).

Between different procedures which have been used to detect p53 protein such as electrochemical (Afsharan et al., 2016b), Surface Plasmon resonance (SPR) (Wang et al., 2009), colorimetric (Li et al., 2013), chemiluminescence (Chen et al., 2013) and field-effect transistor (FET) (Han et al., 2010),

Electrochemiluminescence (ECL) method is one of the non-invasive optical methods (Ramanaviciene et al., 2012) which has been on the focus according to its superb characteristics including simplicity, low-cost, low response time, great selectivity and more importantly ultra-high sensitivity (Afsharan et al., 2016c; Khalilzadeh et al., 2016) thanks to compatibility with utilizing nanoparticles (Balal et al., 2009; Khalilzadeh et al., 2011; Saghatforoush et al., 2009).

It should be noted here that; concurrent employment of different methods together could be taken into consideration. For instance, the

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