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Preparation of quantum dots CdTe decorated graphene composite for sensitive detection of uric acid and dopamine

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ABSTRACT

The assembly of quantum dots (QDs) in a simply method opens up opportunities to obtain access to the full potential of assembled QDs by virtue of the collective properties of the ensembles. In this study, quantum dots CdTe and graphene (Gr) nanocomposite was constructed for the simultaneous determination of uric acid (UA) and dopamine (DA). The CdTe QDs-Gr nanocomposite was prepared by ultrasonication and was characterized with microscopic techniques. The nanocomposite modified electrode was characterized by cyclicvoltammetry (CV), differential pulse voltammetry (DPV) and electrochemical impedance spectroscopy (EIS). Due to the synergistic effects between CdTe QDs and Gr, the fabricated electrode exhibited excellent electrochemical catalytic activities, good biological compatibility and high sensitivity toward the oxidation of UA and DA. Under optimum conditions, in the co-existence system the linear calibration plots for UA and DA were obtained over the range of 3–600 μM and 1–500 μM with detection limits of 1.0 μM and 0.33 μM. The fabricated biosensor also exhibits the excellent repeatability, reproducibility, storage stability along with acceptable selectivity.

1. Introduction

Dopamine is produced by decarboxylation of 3,4-dihydroxyphenyl ethylamine, known to be a significant catecholamine neurotransmitter for the nervous system of human and other mammals. It acts as a neuromodulator in brain circuitry and responsible for several physiological conditions such as mood, behavior, memory, attention and movement endocrine function, reward, emotion and cognition [1–4]. Dysregulation of dopaminergic neurotransmission is associated with attention deficit hyperactivity disorder, mood disorders, schizophrenia and neurodegenerative diseases such as Parkinson's disease and Alzheimer [5–7]. The currently available analytical methods for dopamine determination are spectrophotometry, chromatography [8], UV spectrometry [9], chemiluminescence, capillary electrophoresis [10] and electrochemical methods [11]. Uric acid (UA) is the primary end product of proteins and nucleic acids in human. It is mainly excreted by kidney and to a less extent by liver. Elevated uric acid levels in the urine may indicate gout, Lesch-Nyhan syndrome [12,13], arthritis, leukemia, lymphoma [14], Consequently, serum/urine uric acid measurement is routinely required for diagnosis. Among the various methods available for determination of UA, such as electrochemical [15], HPLC [16], chemiluminescence method, fluorescence method [17]. However, these methods generally involve a time-consuming sample pretreatment step and long analysis times and are relatively expensive and only focus on individual determination. Therefore, a sensitive and selective method for simultaneous determination of DA and UA is highly

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desirable for investigating their physiological functions and diagnosing diseases.

Recently, electrochemical techniques have received considerable interest for the detection of small biomolecules owing to their high sensitivity, rapid response, and low expense. Some multimaterials were reported. UA and DA were simultaneously determined with poly (eriochrome black T)/GCE [18], silver hexacyanoferrate/MWNT/GCE [19], Fe_3O_4 NPs/reduced graphene oxide (rGO)/GCE [20], palladium NP-loaded carbon nanofibers/CPE [21]. Although various materials have been utilized to modify electrodes

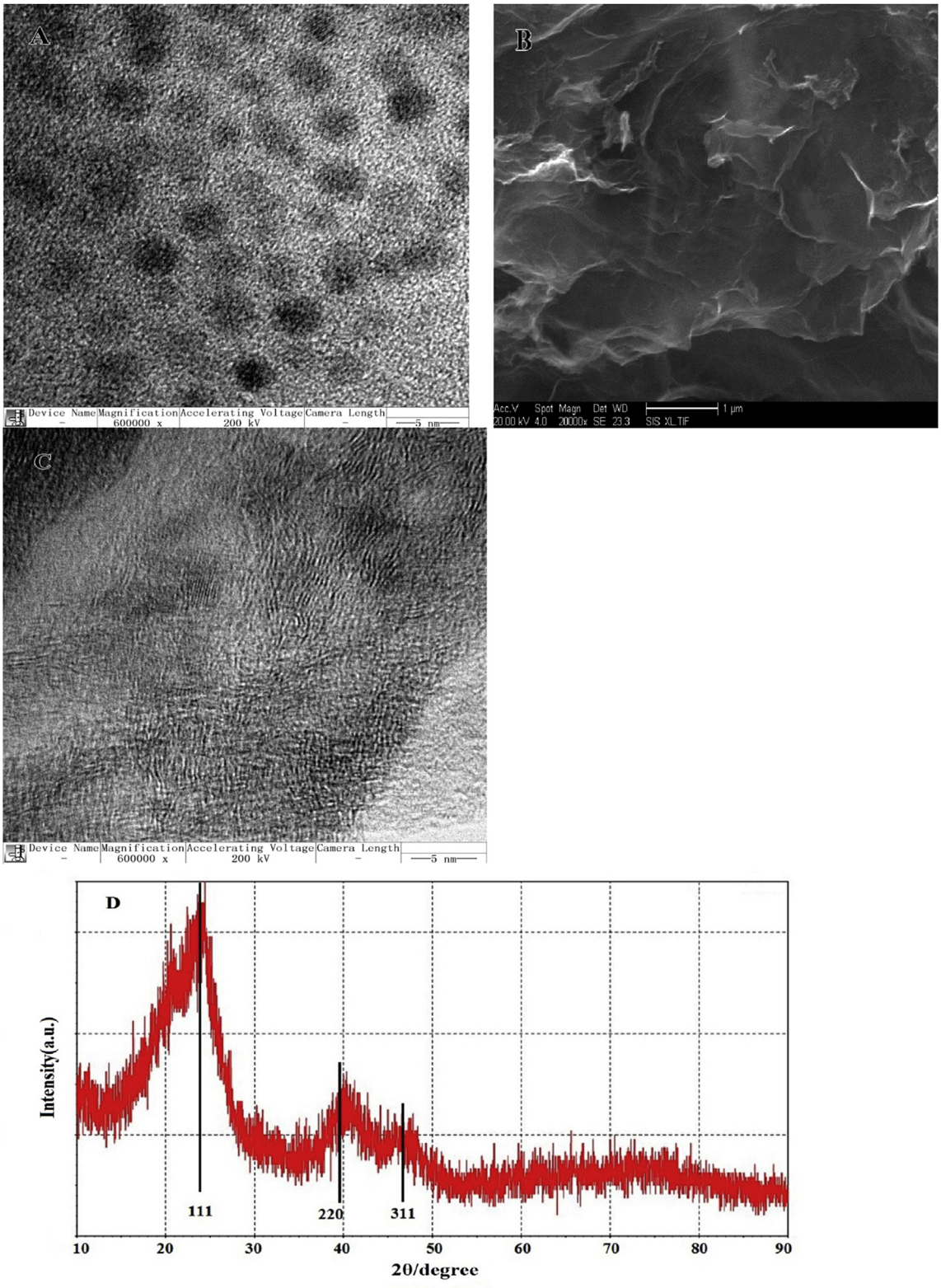

Fig. 1. TEM image of (A) QDs, (B) SEM image of Gr/GCE and (C) TEM image of CdTe QDs-Gr nanocomposite. (D) XRD pattern of CdTe QDs.