In-situ growth of 3D Cu-MOF on 1D halloysite nanotubes/reduced graphene oxide nanocomposite for simultaneous sensing of dopamine and paracetamol

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Abstract

Three-dimensional (3D) metal–organic frameworks (MOFs) a class of porous materials with tunable structure and surface functionality has arisen as electrode materials especially, for electrochemical sensing of analytes. However, MOFs possess intrinsic drawbacks such as poor conductivity with an agglomeration of particles, which restricted the electrochemical signal response in terms of sensitivity and detection limits. In this regard, the present work aims to develop conducting Cu-MOF on HNTs, a good substate for in-situ growth of MOF nanostructures due to the existence of abundant negatively charged Si-OH that can help the growth of nanosized MOFs. The negatively charged siloxane (Si-O-Si) groups on the surface of HNTs can be attracted by positive charged Cu^{2+} ions present in the reaction mixture through strong electrostatic attraction. When subjected to hydrothermal treatment, the Cu^{2+} ions can form nano-sized Cu-MOF particles with assistance from 2-methylimidazole. Moreover, the presence of graphene oxide (GO) can improve the electrical conductivity, large surface area, and thus resulting in the formation of conducting Cu-MOF/HNTs/rGO nanocomposite. Owing to the synergetic desirable properties of active metal sites and high porosity offered by Cu-MOF, the high conductivity of rGO, and the large surface area of HNTs, the resultant Cu-MOF/HNTs/rGO modified GC electrode demonstrates superior electrochemical signal response towards dopamine and paracetamol. Moreover, the developed sensor exhibits wide linear ranges of 0.1 µM–130 µM and 0.5–250 µM, with a low detection limit of 0.03 µM and 0.15 µM for dopamine and paracetamol, respectively.

Author keywords

Dopamine; Graphene; Halloysite nanotubes; MOF; Paracetamol