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Short Communication

Research status and prospect of MOF composites in the field of electrochemical sensing

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Electrochemical biosensor is a detection method which combines bioscience and electronic detection technology. In comparison to conventional inspection methods, electrochemical biosensors provided with relatively high sensitivity, enhanced specificity, and non-invasive detection methods for biomolecules [1]. In recent years, with the rapid development of nanotechnology, new nanomaterials with immense potential are constantly emerging. Nanomaterials with different sizes, shapes, chemical components and unique properties have been adopted for different kinds of biosensing applications, playing an increasingly important role in the development of biosensors [2]. Metal-Organic Framework (MOF) is a porous inorganic-organic hybrid nanomaterial with periodic network structure formed by self-assembly of metal ions and organic ligands. MOF materials have large surface area, excellent electrocatalytic activity and abundant available sites for bioconjugation, and bimetallic MOF materials have more exposed active sites, which can facilitate fast electron transfer, providing all of the criteria needed as the sensing material for electrochemical biosensors application [3,4]. Therefore, the development of new MOF-related nanostructured materials has become the focus of attention.

There are currently related reports about the detection of biomarkers by new nanostructured materials based on MOF as signal amplification elements. Bao, et al. constructed a label-free and stimuli-responsive electrochemical biosensing platform for Carcinoembryonic Antigen (CEA) detection was fabricated based on target-driven loads release from DNA-gated metal-organic framework with cascade amplification by using MOFs (UiO-66-NH2, an organic framework of amino terephthalic acid linked to zirconium junction) as nanocarrier of electroactive molecules (methylene blue, MB) with a detection limit of 16 fg/mL [5]. According to the report of Li's group, an electrochemical strategy based on the cascade primer exchange reaction(PER) with MOF@Pt@MOF nanozyme for ultrasensitive detection of exosomal miRNA with limit of detection down to 0.29 fM [6]. The multi-layered nanozyme consisted of a layer of Pt NPs encapsulated between two layers of MIL-88. MIL-88 is a classical MOF synthesized by solvothermal method between iron salt and amino terephthalic acid. Compared to individual MOF structure, it emerges a more astonishing peroxidase-like activity toward H_2O_2 decomposition. Therefore, MOF materials are of great significance for the trace detection of biomarkers. Meanwhile, MOF with specific affinity properties also earn high favor as selective substrates for chemical detection in ECL sensors. Fang et al. used MIL as a high-quality carrier of ECL emitters for the detection of PCT, and the luminescent properties of g-C_3N_4 could be significantly improved by the interaction of the host and the guest between the MOF and the luminophore [7]. Therefore, in electrochemistry biosensors, the use of multifunctional MOF composites can realize the synergistic effect among all parts and stimulate the new potential of signal transduction. Besides, by integrating functional materials to the MOF, MOF composites may also show the advantages of amplifying electrochemical signals in limited areas, improving the reaction efficiency as well as loading more functional materials to provide a good platform, all of which are conducive to design a new type of electrochemistry biosensor.

Bimetallic MOF derived from mono-metallic MOF has been widely used as an electrocatalyst [8], and has also been reported to be used in the detection of actual samples in the

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field of electrochemical biosensors [9]. It not only improves the narrow linear range, low sensitivity, poor stability and other defects of mono-metallic MOF, but also has the advantages of mono-metallic MOF. The excellent stability and electrical conductivity of bimetallic MOF make its composites with other nanomaterials may have better properties than mono-metallic MOF composites, which paves the way to the development of next-generation MOF composites in the field of electrochemical sensing. However, the application of bimetallic MOF composites in the field of electrochemical sensing is not very wide, and some specific properties of bimetallic MOF combined with other nanomaterials are not completely clear, so there are still many challenges in the development of the composite in the field of electrochemical sensing.

Nevertheless, the rapid development of MOF materials in recent years still indicates a good prospect, and its excellent performance in trace detection of biomarkers may provide ideas for new clinical detection methods in the future. For example, the development of portable wearable devices combined with flexible materials and so on. This shows that there is still a lot of innovative research space for MOF materials in this exciting field, and the continuous research on MOF materials is expected to make MOF materials a wide range of practical applications in the field of sensors.

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