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A novel electrochemical sensor based on molecularly imprinted polymer modified MOF derived exfoliated porous carbon

In this work, we report a novel hybrid electrochemical sensor coupling exfoliated porous carbon (EPC) with molecularly imprinted polymer (MIP) for detection of lidocaine (LID). LID is a local anesthetic and antiarrhythmic drug. It is also the preferred drug in the treatment of myocardial infarction ventricular premature beats and ventricular tachycardia. However, excessive blood concentration of LID can cause cardiovascular and central nervous system diseases. What's more, LID is currently being illegally added into cosmetics to reduce skin damage from sun exposure. Therefore, it is necessary to detect LID in biological fluids and cosmetic products. Electrochemical sensors feature the advantages of easy preparation and operation, low detection limit and high sensitivity, allowing for rapid and on-the-spot monitoring of trace analytes. What's more, we introduced molecularly imprinted technique into electrochemical sensor, molecularly imprinted polymer (MIP) can be used as a very proper target molecule recognizer, improving sensor selectivity.

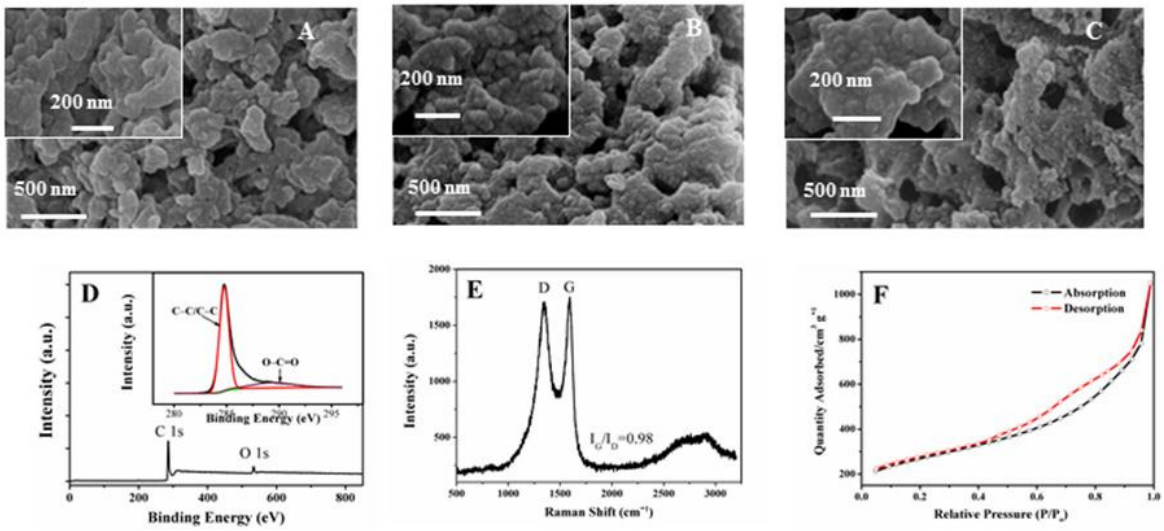

Fig. 1 SEM micrographs of PC (A), MIP/PC before (B) and after (C) extraction of LID. XPS spectrum (inset: high-resolution C 1s spectrum) (D), Raman spectrum (E) and Nitrogen adsorption–desorption isotherm of PC (F).

In addition, studies also point out that sensor substrate is an important factor impacting sensitivity and selectivity. In this respect, we choose metal organic framework (MOF) derived porous carbon, in which MOF is used as a precursor due to its excellent performance like diverse structure and tunable property. In order to obtain porous carbon with less aggregational fragments and better dispersity, further treatment is necessary. N-methyl-2-pyrrolidone (NMP) has been adopted in dispersing two-dimensional materials due to its nonvolatility, low toxicity and high viscosity, which is an ideal option in obtaining fully dispersed and stabilized porous carbon materials via tender and relatively safe operation.

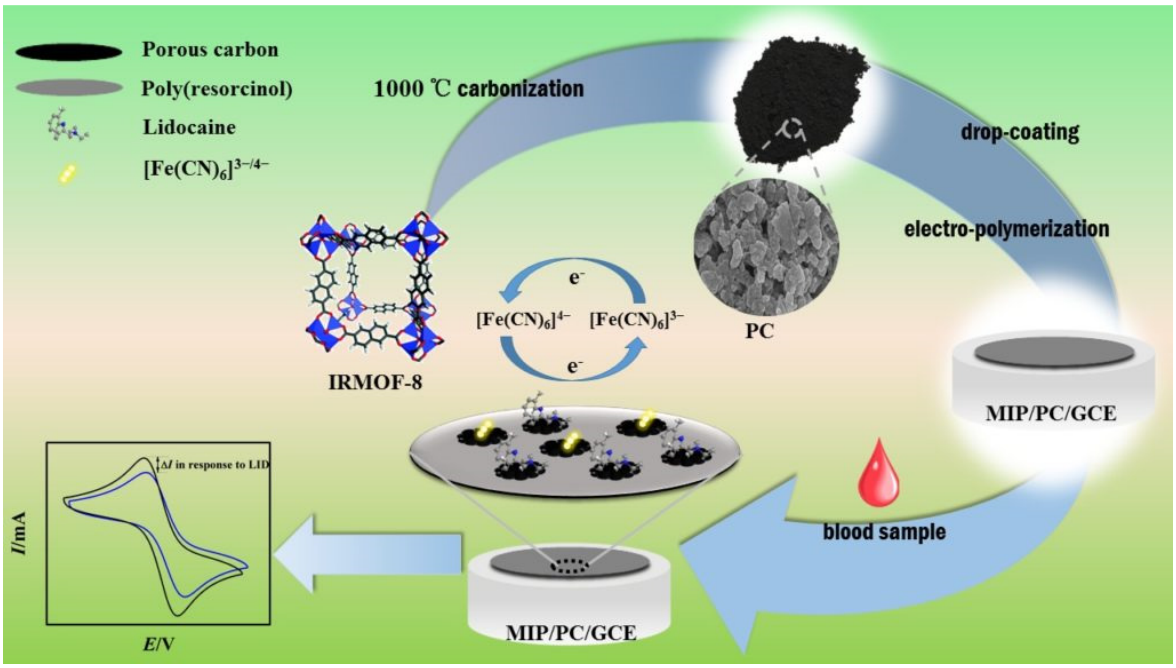

Fig.2 Schematic of a novel electrochemical sensor based on molecularly imprinted polymer modified MOF derived exfoliated porous carbon for determination of lidocaine at trace level.

Morphology, composition and pore structure of PC was carefully characterized, it is worth mention that the Brunauer-Emmett-Teller (BET) surface area and the total volume of EPC were calculated to be 1416.25 m^2 g^{-1} and 1.66 cm^3 g^{-1}, respectively. Relevant parameters influencing the sensing performance were carefully optimized. A wide linear relationship of oxidation peak current shift versus concentration of LD was obtained in the range from 0.2 pM to 8 nM with a low detection limit of 6.7 fM (S/N = 3). Furthermore, the sensor was successfully employed to detect LD in rat blood samples with its reliability confirmed by "gold" method-HPLC. It is highly expectable that this fascinating porous carbon material and its application together with MIP will play an important role in electrochemical detection field.

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Publication

Voltammetric lidocaine sensor by using a glassy carbon electrode modified with porous carbon prepared from a MOF, and with a molecularly imprinted polymer.
Junjie Zhang, Jiang Liu, Yang Zhang, Feng Yu, Fu Wang, Zhengchun Peng, Yingchun Li
Mikrochim Acta. 2017 Dec 26