Graphene based sensors for heavy metals or organic micropollutant electrochemical detection

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Since its exfoliation in 2004, graphene attracted an huge interest in scientific and in industrial communities due to its physical and chemical properties. Furthermore, graphene highlights different strong interactions with its environment, as chemical interactions, or physical interaction. These graphene properties can be used for sensing application, in mechanical, biological and chemical fields. Then one of the main challenge of our modern society, is the evaluation and the control of pollution in the environment, especially for the air and water quality. For water, the European Union has edicted the water frameworks directive in 2000. The revision of this directive (2013) defines new thresholds of detection and new settings for the analysis of 45 priority micropollutants in aqueous media. These micropollutants belong to different chemical families including heavy metal ions as Nickel, Lead or organic molecules such as Polycyclic Aromatic Hydrocarbons (PAH) or pesticides for example. This chemical diversity involves the development of selective and sensitive sensors for their detection. In the laboratory ICMN, we develop electrochemical sensors dedicated to the detection of micropollutants in aqueous media.
In this way, for performing the detection of heavy metals, or Polycyclic Aromatic Hydrocarbons (PAH), we used graphene as an electrochemical platform, for grafting of diazonium salt for the detection of targeted heavy metals[1], or performing electropolymerization of the Molecular Imprinted Polymer (MIP) for the detection of PAH [2,3]. After this step of graphene modification, the functionalized graphene sensors were used for the detection of targeted molecules. The detection process is performed in two steps, the first is the adsorption of the micropollutant in the selective layer, and the second is the electrochemical analysis. In this study, CVD graphene and electrochemically exfoliated graphene were used as electrochemical platform for these sensors. Three priority micropollutants were detected one heavy metal, one pesticide, and one PAH.
We will present here, 100% graphene based sensors. One dedicated to the detection of copper based on electrochemical exfoliated graphene electrodes modified by diazonium salt grafting. The second one dedicated to the detection of Anthracene or isoproturon based on CVD graphene electrodes modified by an electropolymerized MIP. For these three micropollutants concentrations at ppb level have been obtained.
At each steps of the sensors elaboration, we characterized their properties and structures of the materials by different techniques such as, Raman spectroscopy, Atomic Force Microscopy, Scanning Electron Microscopy, and electrochemistry.
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References

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