Metal-free Cysteamine Functionalized Graphene Alleviates Mutual Interferences in Heavy Metals Electrochemical Detection

Presenting Author (Qiuyue Yang and David Panáček)
Co-Authors (Qiuyue Yang, Emily P. Nguyen, David Panáček, Veronika Šedajová, Vítězslav Hrubý, Giulio Rosati, Cecilia de Carvalho Castro Silva, Aristides Bakandritsos, Michal Otyepka, Arben Merkoçi*)
Institut Català de Nanociència i Nanotecnologia (ICN2), Campus de la Universitat Autònoma de Barcelona, Edifici ICN2, Av. de Serragalliners, 08193 Bellaterra, Barcelona
arben.merkoci@icn2.cat

Abstract:

The detection of heavy metal pollutants is of great concern in environmental monitoring due to the potent toxicity. Electrochemical detection, one of the foremost sensing techniques, is hindered by the mutual interference between target heavy metal ions. In particular, the sensitivity to Cd^{2+} (one of the most toxic heavy metals) is often overshadowed by other heavy metals (e.g., Pb^{2+} and Cu^{2+}) when using carbon electrodes. [1,2] Strategies are frequently required using additional metallic particles embedded in the electrode, which faces recycling and reusability issues. In this study, a metal-free cysteamine covalently functionalized graphene (GSH), is employed to tackle this issue by selectively enhancing a 6-fold boost in Cd^{2+}sensitivity of screen-printed carbon sensors (SPCE), while the sensitivities to Pb^{2+} and Cu^{2+} not being influenced in the simultaneous detection. The selective enhancement is attributed to grafted thiols on GSH, which have good affinity to Cd^{2+} based on Pearson's hard and soft acid and base principle. Moreover, GSH-SPCE features high reusable times (23 times) due to the covalent functionalization of thiols, surpassing the state-of-art SPCEs modified by non-covalently functionalized graphene derivatives. Finally, GSH-SPCE was validated in tap water.

References

[1] Yang, Qiuyue, et al. "Development of a heavy metal sensing boat for automatic analysis in natural waters utilizing anodic stripping voltammetry." ACS ES&T Water 1.12 (2021): 2470-2476.
[2] Borrill, Alexandra J., Nicole E. Reily, and Julie V. Macpherson. "Addressing the practicalities of anodic stripping voltammetry for heavy metal detection: a tutorial review." Analyst 144.23 (2019): 6834-6849.

Figures

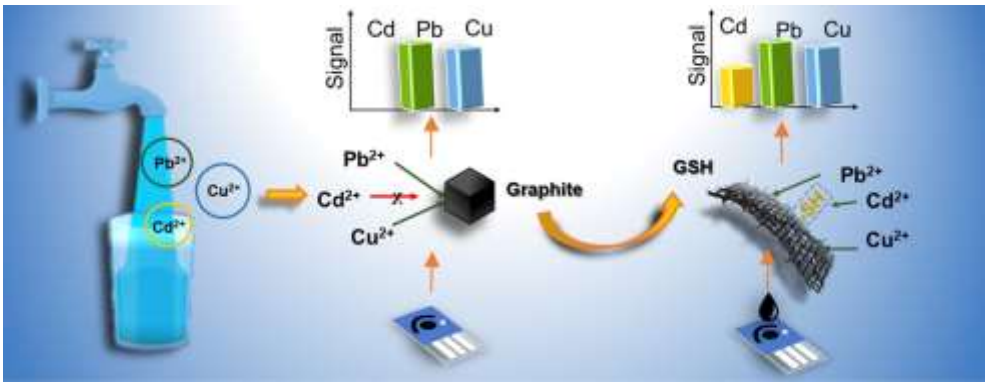

Figure 1: Schematic illustration of the significant effect of GSH relieving the mutual interference in simultaneous multiple heavy metals detection.