Toward integrated detection and graphene-based removal of contaminants in a lab-on-a-chip platform

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In this work a miniaturized microfluidic platform for the simultaneous detection and removal of polybrominated diphenyl ethers (PBDEs) is developed. This device consists of a polydimethylsiloxane (PDMS) microfluidic chip for an immunoreaction step, a PDMS chip with an integrated screen-printed electrode (SPCE) for detection and a PDMS-reduced graphene oxide (rGO) chip for physical adsorption and subsequent removal of PBDE residues. The detection was based on competitive immunoassay (PBDE vs. HRP-PBDE) followed by the monitoring of enzymatic oxidation of o-aminophenol (o-AP) using square wave anodic stripping voltammetry (SW-ASV). PBDE was detected with the limit of detection similar to that obtained with a commercial colorimetric test (0.018 ppb), but with the advantage of using lower reagent volumes and a reduced analysis time. The use of microfluidic chips also provides improved linearity and a better reproducibility in comparison to those obtained with batch-based measurements using screen-printed electrodes. In order to design a detection system suitable for hazardous compounds such as PBDEs, a reduced graphene oxide–PDMS composite was developed and optimized to obtain increased adsorption (based on both the hydrophobicity and π–π stacking between rGO and PBDE molecules) compared to those of non-modified PDMS. To the best of our knowledge, this is the first demonstration of electrochemical detection of flame retardants and a novel application of the rGO-PDMS composite in a biosensing system. This system can be easily adjusted to detect any analyte using the appropriate immunoassay and it supports operation in complex matrices such as seawater.

References

[1] Chałupniak, A. & Merkoçi, A. Nano Res. (2017). doi:10.1007/s12274-016-1420-3

Figures

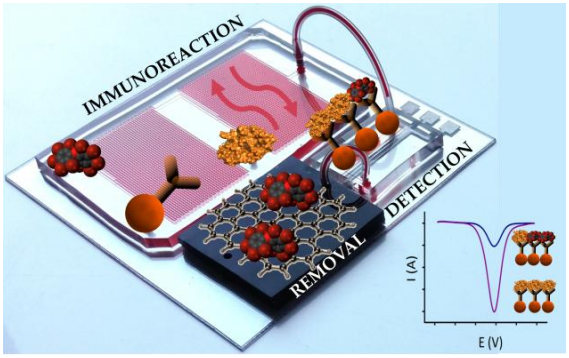

Figure 1: Lab-on-a-chip platform for electrochemical detection and graphene-based removal of polybrominated diphenyl ether (PBDE).

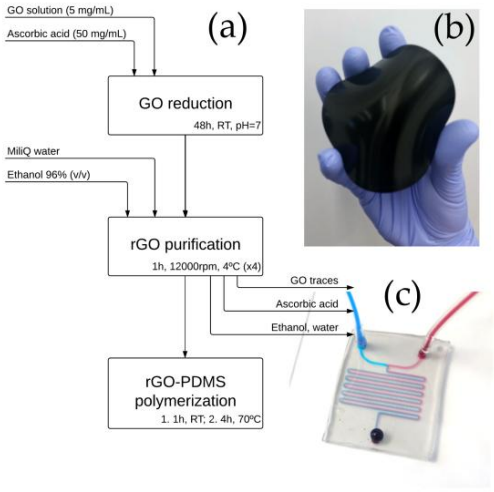

Figure 2: rGO-PDMS composite (a) fabrication process, (b) a solid piece or rGO-PDMS, (c) rGO-PDMS-glass microfluidic chip.