Proc. of the Intl. Conf. on Nanotechnology for Better Living, 2016
Editors K. K. Kar, A. Shah and R. Sharma
Vol. 3, No. 1, p. 109
doi:10.3850/978-981-09-7519-7nbl16-rps-109

NBL-2016

Highly reproducible and sensitive detection of small organic pollutants via reduced graphene oxide based 'turn-on' fluorescent sensor

Arindam Saha[1]* and Reetam Mitra[2]

[1]Sensor and Actuator Division, CSIR-Central Glass and Ceramic Research Institute, Kolkata-700032, India.
[2]Department of Chemical Engineering, Jadavpur University, Kolkata-700032, India.
*Email: arindamchemiitkgp@gmail.com

Quantitive and reproducible 'on-field' detection of small organic pollutants possesses major challenges to the scientific community and environmental institutions. These organic pollutants normally present in drinking water, surface water, industrial waste water, canned food materials and baby bottles in small amounts creating difficulties in their precise determination. Although this organic pollutants present in small amount, it causes serious health issues for living beings by creating acute diseases and destroying the ecosystem. Here we focus on four major organic pollutants - Bisphenol A (BPA), 1-naphthol (NP), phenol (PH) and picric acid (PA) in which BPA is a well-known endocrine disruptor. The major difficulties in detecting these pollutants are- (i) ultralow concentration, (ii) exact quantification, (iii) separation from aqueous phase and (iv) reproducibility of detection.

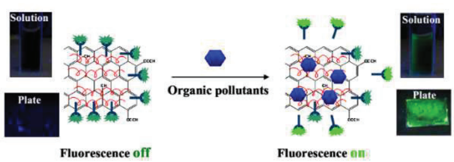

Figure 1: Schematic representation of 'Turn-On' Fluorescent approach for the detection of small organic pollutants. Digital images show solution based approach as well as paper based approach for the detection.

Graphene based optical and electrochemical sensors have gained amplified attention in last decade and have been widely used to detect various small biomolecules and small organic pollutants.[1,2] We have developed a graphene based composite platform for optical 'turn-on' detection of organic pollutants (BPA, NP, PH, PA). As synthesized graphene oxide (GO) is first converted to reduced graphene oxide (RGO) followed by polystyrene sulfonate (PSS) attachment to develop a RGO-PSS composite. Dextran fluorescein (Dex-fl) is then loaded on this material as fluorescence reporter. This composite (RGPD-fl) result in completely quenched fluorescence due to close proximity between the surface of graphene and fluorescein molecules. On addition of organic pollutants in varying concentration (milimolar to picomolar), it interacts strongly with the graphene surface and releases dextran-fl from graphene surface. As a result, fluorescence reverts back in solution due to enhanced separation between graphene surface and fluorescein molecules. This 'turn-on' detection approach shows high sensitivity (in the order of nanomolar) and good reproducibility. This approach has been extended for on-field detection of organic pollutants. For this purpose, silica gel based thin layer chromatography (TLC) plates are cut into small pieces followed by loading with composite solution by simple dip-coating approach. After air drying, a drop of organic pollutant is added and enhanced fluorescence is observed under UV-light (365 nm excitation). We have tested surface water, drinking water and industrial waste water for quantitive BPA detection using our approach following a standard addition method. We have detected appreciable amount of BPA in waste water and surface water. Whereas, BPA content in purified drinking water is too low to detect by this approach.

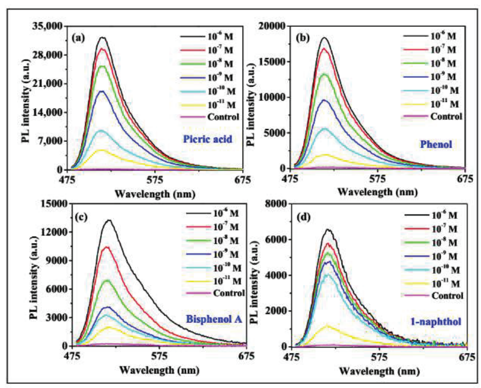

Figure 2: 'Turn-On' fluorescence response of four different organic pollutants, picric acid (a), phenol (b), bisphenol A (c) and 1-napthol (d) towards RGPD-fl composite probe. With increasing concentration of organic pollutants, recovered fluorescence intensity increases as evidenced from the figure. Fluorescence response differs for pollutants studied. Picric acid (a) show strongest response while 1-napthol (d) show weakest response.

References

1. A. Saha, SK Basiruddin, S. C. Ray, S. S. Roy, N. R. Jana. Nanoscale, 2 (2010), 2777.
2. A. Saha, S. Palmal, N. R. Jana. Nanoscale, 4 (2012), 6649.