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Luminescent Functionalized Graphene Oxide Based Sensitive Detection of Deadly Explosive TNP

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Abstract : In the 21st century, sensitive and selective detection of trace amounts of explosives has become a serious problem. Generally, nitro compound and its derivatives are being used worldwide to prepare different explosives. Recently, TNP (2, 4, 6 trinitrophenol) is the most commonly used constituent to prepare powerful explosives all over the world. It is even powerful than TNT or RDX. As explosives are electron deficient in nature, it is very difficult to detect one separately from a mixture. Again, due to its tremendous water solubility, detection of TNP in presence of other explosives from water is very challenging. Simple instrumentation, cost-effective, fast and high sensitivity make fluorescence based optical sensing a grand success compared to other techniques. Graphene oxide (GO), with large no of epoxy grps, incorporate localized nonradiative electron-hole centres on its surface to give very weak fluorescence. In this work, GO is functionalized with 2, 6-diamino pyridine to remove those epoxy grps. through SN2 reaction. This makes GO into a bright blue luminescent fluorophore (DAP/rGO) which shows an intense PL spectrum at ~384 nm when excited at 309 nm wavelength. We have also characterized the material by FTIR, XPS, UV, XRD and Raman measurements. Using this as fluorophore, a large fluorescence quenching (96%) is observed after addition of only 200 µL of 1 mM TNP in water solution. Other nitro explosives give very moderate PL quenching compared to TNP. Such high selectivity is related to the operation of FRET mechanism from fluorophore to TNP during this PL quenching experiment. TCSPC measurement also reveals that the lifetime of DAP/rGO drastically decreases from 3.7 to 1.9 ns after addition of TNP. Our material is also quite sensitive to 125 ppb level of TNP. Finally, we believe that this graphene based luminescent material will emerge a new class of sensing materials to detect trace amounts of explosives from aqueous solution.

Keywords : graphene, functionalization, fluorescence quenching, FRET, nitroexplosive detection
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