Thermal Desorption of Explosives Vapour from Organic Fluorescent Sensors

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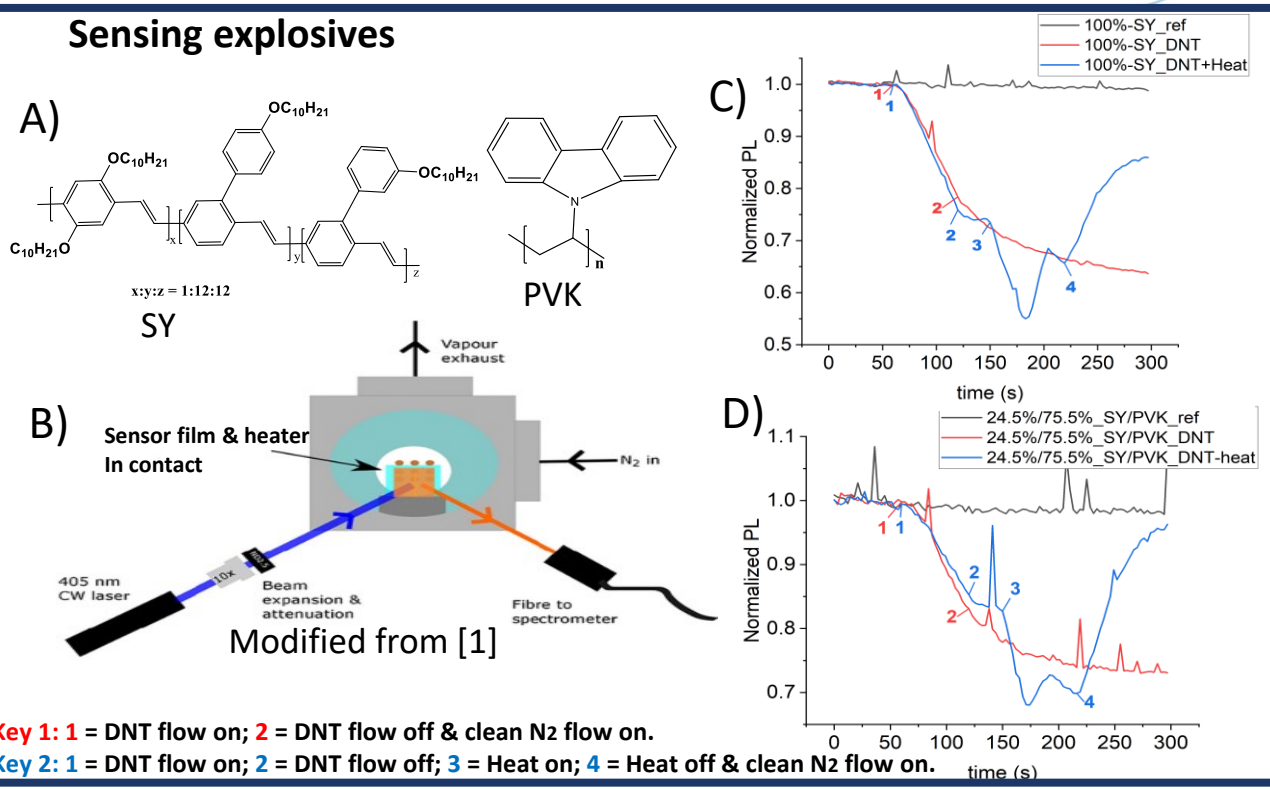
Abstract

Organic semiconductors can be used as highly sensitive fluorescent sensors for the detection of trace-level vapours of nitroaromatic explosives. This involves fluorescence quenching of the sensors and indicates the presence of explosives in the surrounding environment. However, for many organic fluorescent sensors, the quenching of fluorescence is irreversible and imposes a limitation in terms of the reusability of the sensors. Here, we present a study of thermal desorption of 2,4-DNT from thin-film explosives sensors made from the commercial fluorescent polymers, Super Yellow and poly(9-vinyl carbazole). Thermal cycling of the sensor results in recovery of fluorescence thereby making them reusable.

Sensing explosives



Key 1: 1 = DNT flow on; 2 = DNT flow off & clean N_2 flow on.
Key 2: 1 = DNT flow on; 2 = DNT flow off; 3 = Heat on; 4 = Heat off & clean N_2 flow on.

Project Description

- Thin film explosives sensors were fabricated using commercially available conjugated polymer, Super Yellow (SY), and a blend of SY and poly(9-vinyl carbazole) (PVK).
- Sensors were optically excited using 405 nm CW diode laser, and fluorescence monitored using fibre coupled spectrometer
- 2,4-DNT vapour exposure for 60 s resulted in quenching of the fluorescence of the sensors, and a continuing decrease of the fluorescence was observed even when the DNT source was turned off and the system was flushed with a clean nitrogen source. For resetting, sensors were heated from room temperature to 90 °C and then flushed with a clean nitrogen source.

Key Results & Conclusions

- commercially available conjugated polymer Super Yellow (SY) can be used as a highly sensitive and reusable sensor for nitroaromatic explosives
- An increase in the temperature of the sensors weakens the analyte binding interaction and allows the sorbed analytes to diffuse out of the thin film which results in the recovery of PL of the sensors
- PVK was blended with SY which shows an improvement during thermal desorption of the analytes when resetting the sensors
- This method can be applied to other organic fluorescent sensors, removing the limitation of single-use sensors.

[1] Gillanders et al,. https://doi.org/10.1016/j.scitotenv.2018.12.160