Scottish Universities Physics Alliance

Toolbox Implementation for Removal of Anti-personnel Mines, Submunitions and Uxo

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Advances in the Development of a Polymer-Based Sensor System for Explosives Detection

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Organic Semiconductors

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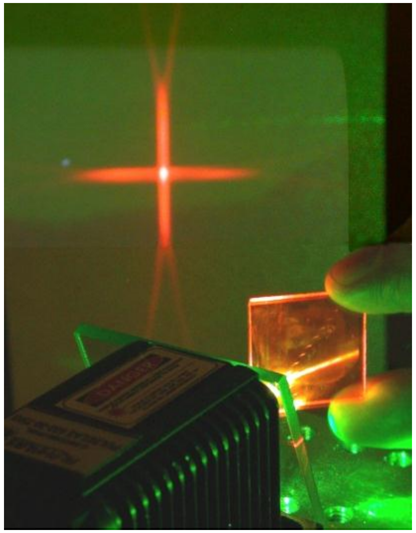
- Semiconducting polymer materials
- Mechanically flexible
- Solution-processed
- Strong light emission
- Uses include solar cells, displays, polymer lasers, and photodynamic therapies



Organic Semiconductors and Explosive Sensing

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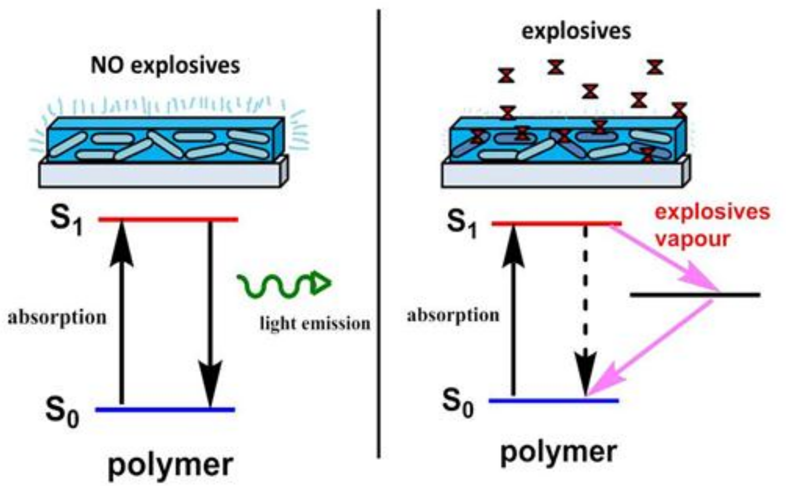
- Organic semiconductors have high sensitivity to nitroaromatics, such as TNT
- Light emission drops significantly by a process known as *quenching* when in contact with nitroaromatics
- This quenching effect can be exploited to detect explosive vapours



Development of portable chemical sensing system

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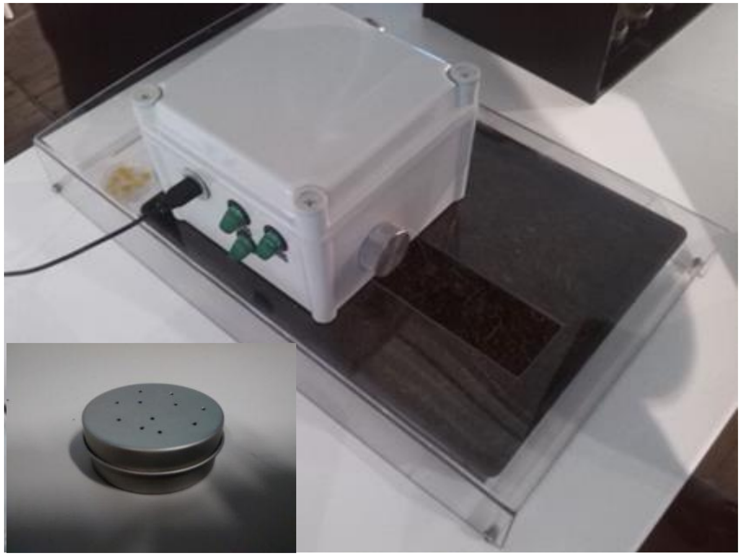
- Requirement for a robust, lightweight, user-friendly instrument for use in the field
- Part of a toolbox to complement other methods e.g. metal detectors, GPR
- Sampling methods, optics, electronics and software development to take optical sensors from lab to "real world"
- Modularity and ease-of-use are key design factors

Prototype

Physical characteristics

- Internal pump samples air above contaminated soil
- Modular box design allows for handheld (2kg) or vehicle-mounted use



Operability

- Chemical sensor loaded with simple locking bracket
- Clear user interface displays green/red safe/unsafe light system

Characteristics

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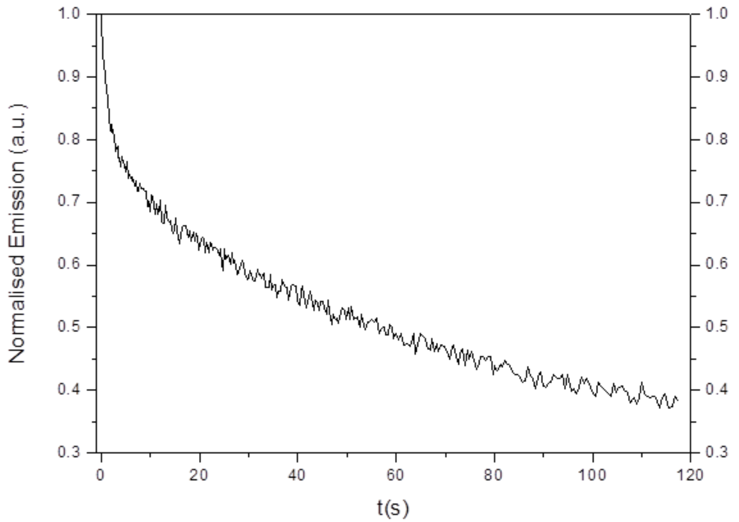
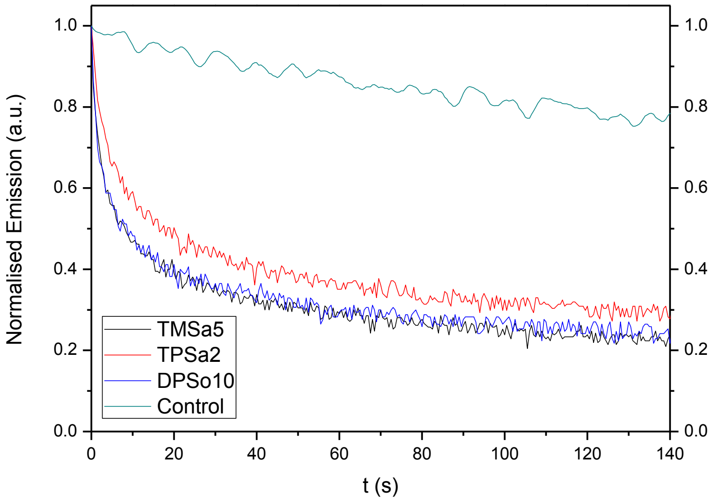
Calibrated Vapour detection

- DNT vapour in nitrogen flowed through detection chamber
- Decrease in light emission indicates explosive vapour



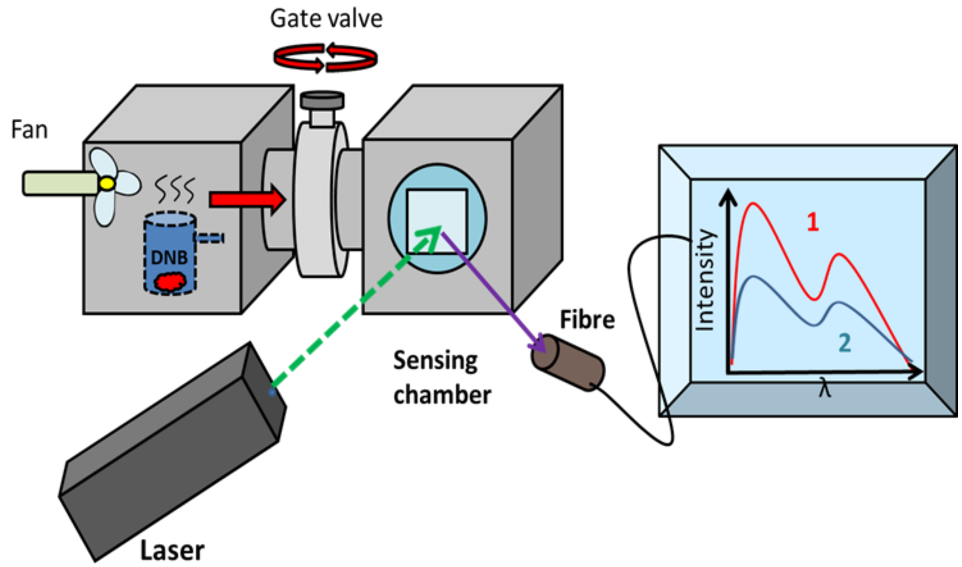
Buried explosives detection

- TNT and DNT buried under sand and soil at 2 cm, 5 cm, and 10 cm in metal or plastic casings.



REST filters

- Remote Explosive Scent Tracing
- Explosive molecules from sampled air adsorb to filter
- The filters are then exposed to sensing film
- Acts as a "pre-concentrator" for the vapours



- Currently there is a time delay between sampling on the field and testing filters in the lab

Performance

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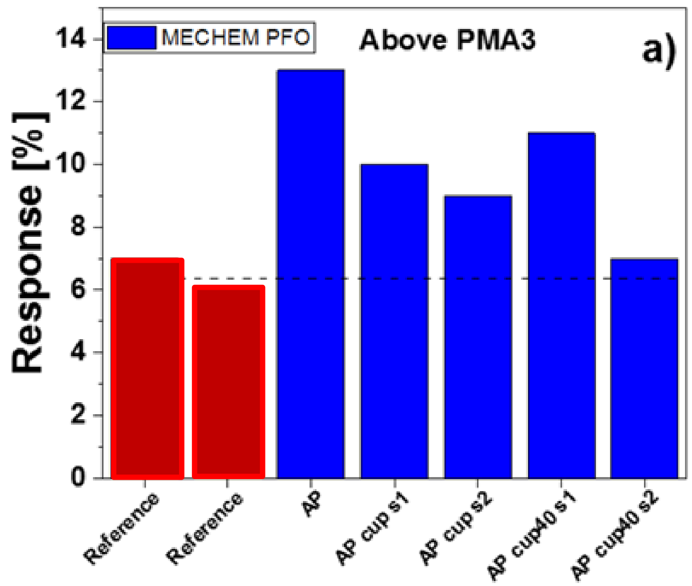
- Early results indicate that sampling in the field can be detected in the lab-based set-up
- Contaminated filters show a higher response than control filters



- Response of a PFO sensor to samples collected above the PMA3 landmine using MECHEM filter (with J. Filipi & N. Kezic)

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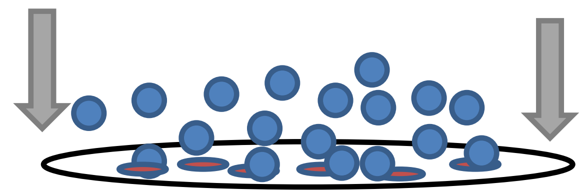
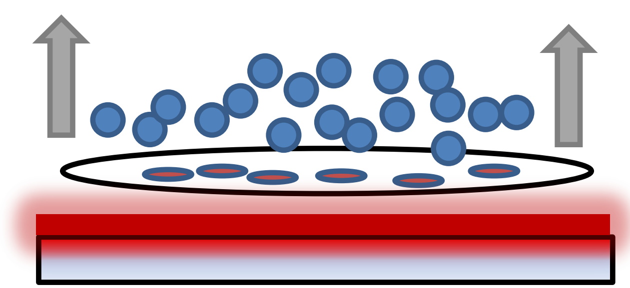
Upgrading the prototype

- Identification of potential improvements in the optical instrument for field use
- Integration of heating element for pre-concentrator filter
- This allows sampling and testing to be done on-site in real time



1. Air is drawn through the filter, explosive vapours adsorb to polymer surface



2. Heating desorbs the vapours, sensor film used for detection

Aqueous Explosives Sensing

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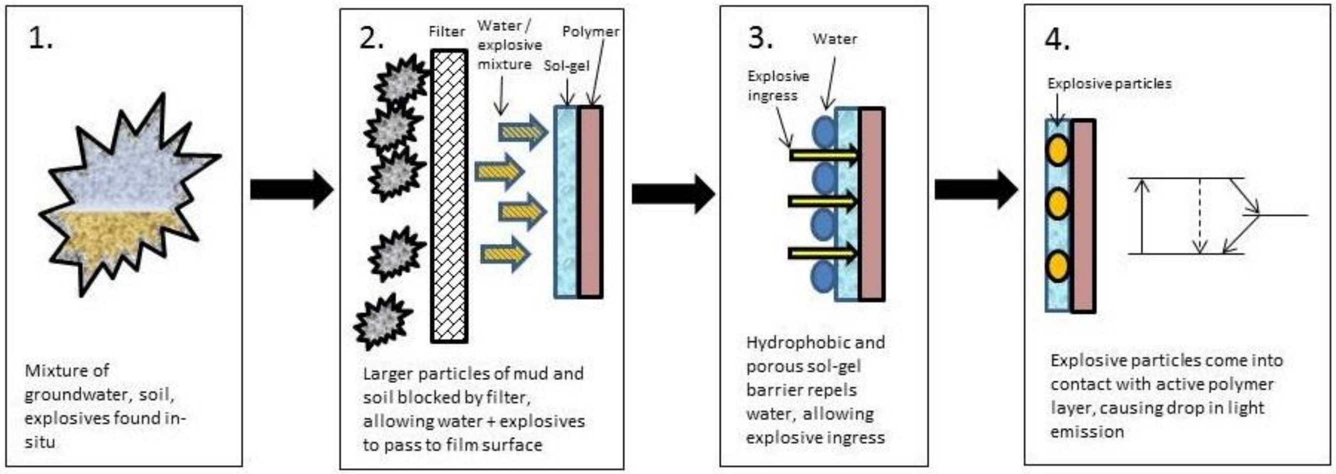

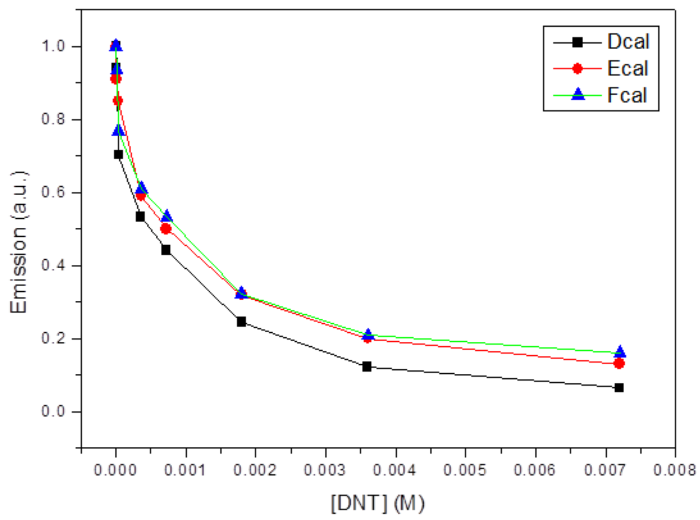

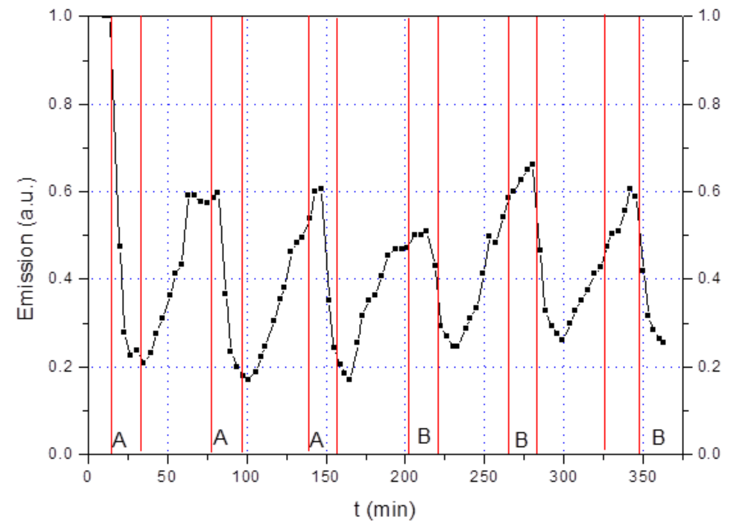

Conclusions

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- Characterisation of upgraded prototype in both bench-top and simulated landmine tests at St Andrews ongoing
- Field trials in late summer/early autumn with upgrade
- Further development of sol-gel barrier films for aqueous sensing – including instrument development