Advanced detection of airport threat under development

Sensitive detection has always been at the forefront of the aviation industry, in particular, the detection of drugs and explosives in order to apprehend potential terrorist threats. Sensitive detection requires sensitive devices, which are calibrated from stock samples of these substances – these exist for solid and liquid samples, but for explosives, vapour stock samples are more difficult to produce. Current solutions are vapour generators which are large, static and expensive, whereas new technology is being developed to overcome each of the aspects – a vapour generator that is small, relatively cheap and portable.

The technology this research focuses on is a combination of molecularly imprinted polymers (MIP) and optical fibres, where the MIP is used a trapping system, to capture an explosive compound, and once trapped, its release is triggered at a controlled rate, where the concentration of the vapour can be analysed by detection devices. The MIP will be created on the surface of the optical fibre, which will be used as a substrate and to quantify the MIP response in testing stages. The current technology applied uses a surface plasmon resonance (SPR) effect for detection – the light waves interact so that the change in the refractive index of the surface, will cause a wavelength shift in the response i.e. when the MIP traps the explosive compound, it will shift depending on the concentration.

The detection devices will be provided by Smiths Detection, as part of their drugs and explosives detection. This technology has initially been tested at City, University of London and will continue to, with potential testing at Smiths Detection premises in later stages. As mentioned, the purpose of the technology is for the aviation industry, specifically airports, with potential applications in other sectors requiring a similar need for explosive vapour calibration.

The launch date is uncertain at the moment, but shows promises with collaborations between City, University of London, Smith's Detection-Walford Ltd and Department for Transport, with support from Imperial College London in sensor creation stages.

The overall aim of the project is to create a molecularly imprinted polymer-optical fibre based sensor that is able to trap and subsequently release explosive vapour. My involvement in this area of research stems from my previous research in molecularly imprinted polymers and my interest developed due to the application to optical fibres and further, the defence and aviation industry. Not only is this an interesting project that can have a variety of applications on completion, it is also an opportunity to make an impact of society and something tangible – research steeped in a goal to make a difference.

In recent history, terrorism has been a prime focus of the aviation industry; from the attack in Brussels airport to apprehending suicide bombers with underwear laden with explosives, the landscape of terrorism has continued to transform, which requires new, sensitive technology or adaptations made to those that exist currently. The former attack in Brussels occurred in 2016, where two nail bombs were detonated in the check-in area, followed by a coordinated attack in Maelbeek metro station around an hour later. As a result, the project started from a need to improve sensitivity of detection technology.

To start the project, research was focused on using a dummy analyte to prove the functionality of the technology. Codeine was chosen as previous research at City had achieved a molecularly imprinted polymer for the detection of cocaine, and due to the similarity in their structure. This started with a focus of a fluorescence-based detection which was sensitive and selective to codeine, however, the use of a fluorophore limited the continued usage of the sensor. Amongst the polymer makeup was the inclusion of a fluorophore, whose presence would increase the level of fluorescence in line with the increase of codeine concentration. However, the MIP process requires a washing stage in order to create the gaps for the target analyte to bind – this also needs to be performed after every analysis to allow for rebinding. In the case of the fluorescence-based sensor, the level of fluorescence would reduce after each washing stage, meaning that the sensor was not reusable and was rather suited to be a disposable sensor. This is because the detection device would have to be calibrated each time, as the former high concentrations would be mistaken for those of lower concentrations. To improve on this, research was developed to focus on **surfacer** plasmon resonance-based sensors with MIPs. SPR is a sensitive technique that does not require a fluorophore and is not susceptible to the washing step like fluorescence-based ones. Its focus is on the change in refractive index, affected by the binding of the analyte in the MIP complex, which results in a wavelength shift rather than fluorescence intensity change. How this is achieved, is coating the optical fibres with gold to induce "the SPR effect" along with a silver-coated tip, which is then the substrate for the attachment of the MIP. At the moment, this is where the research has been focused – an SPR-based sensor for codeine, perfecting the right refractive index of the MIP complex for detection. This will be a consideration regardless of the analyte – the MIP, amongst other parameters, needs to meet a certain refractive index threshold, giving a large SPR dip. This is continuing to be perfected, simultaneously investigating codeine and an explosive compound.

As work continues, the lessons learned are those that are only gained through failing and trying again as is the nature of experimental research. Seeking help from experts is something that I have learned and will continue to do as I progress through this project and generally as a scientist. The next steps are to continue building the SPR sensor and converting this to an explosive compound, to then embark on the vapour generation aspect.