

# Defence-related Research Action - DEFRA

**ACRONYM:** ThreatSens

**Title:** Sensitive on-site threat detection towards Defence security

**Duration of the project:** 01/01/2024 - 01/01/2028

**Budget:** 826.340 €

**Key words:** Explosives, sensing, electrochemistry

**of which RHID contribution:** 766.938€

## PROJECT DESCRIPTION

Explosives are a threat to the well-being of our societies, especially due to a tremendous increase in terrorist attacks around the world including Western Europe. Considering their destructive power, ease in procurement and the availability of online tutorials for manufacture and deployment, explosives are an easy weapon of choice in many ambush/terrorist attacks. Belgium plays a central role in this part: on one hand, it has become clear from the Brussels attack, 22 March 2016, that we as a country are a target for terrorist attacks. On the other hand, our Defence forces actively protect the local population in conflict areas by de-mining operations (*e.g.* participation in operation UNIFIL in Lebanon). Such security needs have generated major demands for innovative field-deployable devices for on-site monitoring of explosives materials found in bombs, mines and IEDs (Improvised Explosive Devices) in a sensitive, fast, simple, reliable, and cost-effective manner to be used by non-experts. The current on-site identification tools, such as color identification kits and canines, lack accuracy and selectivity and thus often result in false positives and false negatives. Moreover, portable Raman and Fourier transform infrared instruments used for explosive detection possess several drawbacks including complexity in operation, challenges with interpretation of the results and high purchase costs. Moreover, the confirmatory analytical tests such as gas chromatography and liquid chromatography coupled to mass spectrometry, surface enhanced Raman spectroscopy, X-ray fluorescence spectrometry, or ion spectrometry performed in centralized laboratories are expensive and time-consuming. Therefore, there is a pressing need to develop novel sensing technologies that can allow rapid on-site detection of explosives, with the same accuracy features as existing laboratory-based detection techniques.

Hence, ThreatSens will develop for the first time a smart, portable, fast (<1min) electrochemical device for detection of a large range of explosive materials. It will provide a rapid on-site solution to detect the presence of explosives by developing powerful screening devices which can easily be used by Defence authorities. The research will consist of creating electrochemical fingerprints (EFs) of different classes of explosive materials (*e.g.* nitroalkanes, nitroaromatics, nitroamines, nitrate esters, acid salts

and peroxides) using in-house manufactured screen printed electrodes employing sensitive square wave voltammetry technique and portable potentiostats where advanced data analysis will be done by an algorithm in the form of a software application. Moreover, electrode modifications with cutting edge layered nanomaterials such as graphdyne and MXene will be performed to enhance the selectivity and sensitivity towards explosives and to achieve low detection limits. The applied electrochemical sensing approach, through its high sensitivity and selectivity, will overcome the issues related to the existing on-site tests, as it would reveal the unique fingerprint of each explosive as a voltammetric response, allowing at the same time its quantification. This specific EF will consist of information regarding (i) the nature of the explosives based on the electron transfer reaction (commonly reduction) and (ii) their concentration (as the value for the peak current). By creating EFs of different classes of explosives, a database will be generated for easy and fast (<1 min) detection of different explosives by the end-users (*e.g.* Defence authorities) to avoid potential terror attacks. At the same time, the database will enable to identify trace residues and debris on-site post-explosion. A faster and more accurate on-site analysis of post-explosion samples would offer authorities a great asset in the measures to be taken after an explosion. The project will be accomplished by the strategic partnership of A-Sense Lab at University of Antwerp with Royal Military Academy (RMA) and Coris BioConcept, a SME based in Gembloux, Belgium. End-users from Belgian Defence, DOVO, Belgian Police and customs, Guard company Series and Bomb disposal company Adede will be involved from the beginning of the project (defining end-user requirements) and throughout the project (demonstrations).

Concluding, it is the goal of ThreatSens to provide a rapid on-site solution to detect the presence of explosives by developing powerful screening devices which can easily be used by Defence authorities. Development of such a rapid detection tool for explosives will boost the existing threat prevention capacity of our Defence forces revealing the presence/absence of explosives to be conveniently applied on-site. The exploitation of ThreatSens will be ensured by DEFRA - Call for proposals 2023 3/48 establishing a spin-off company which will enhance the research activities within Defence services. Deploying the proposed device into real practice, ThreatSens will entail significant benefits in Defence operations to support various counter-terrorism surveillance activities along with contributing to the (i) freedom of manoeuvre, (ii) protection of critical Defence infrastructure and (iii) social safety. To further disseminate the findings, a.o. scientific publications, patents, conference contributions, workshops, promotional videos and a final project conference will be prepared.

## CONTACT INFORMATION

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## LINK(S)

Detailed information on the project can be found on the following pages:

- <https://www.uantwerpen.be/en/research-groups/a-sense-lab/research/research-projects/threatsens/>