



FORENSIC RESEARCH PROJECT

RESEARCH PROJECT

Title	: Electrochemical characterization of Explosives
Keywords	: Electrochemistry, on-scene analysis, explosives
Forensic Expertise Area	: Explosions & Explosives
Department	: Biomedical Engineering & Physics
Institute/Company	: University of Antwerp
City	: Antwerp
Country	: Belgium
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SHORT DESCRIPTION

Both for forensic pre and post explosion investigations there is a need for rapid, non-invasive detection and characterization of explosives and explosive residues at the incident scene. This aids decision making (neutralization and evacuation) in case of intact IEDs and sampling strategies for lab analysis and forensic reconstruction (bomb location) in case of a post explosion scene.

Recently the group of prof Karolien de Wael of the University of Antwerp developed and designed a novel platform for the rapid and field deployable electrochemical detection and characterization of drugs of abuse. Especially in combination with existing colorimetric tests this could yield robust chemical identification strategies. The NFI and the University of Antwerp have started a collaboration to look into the possibility to use this platform in the field of forensic explosives investigations. A MSc co-internship project with a MSc student from the University of Antwerp looking into the electrochemistry and a MFS student from the University of Amsterdam focusing on the forensic applicability is available. In addition to a first proof of principle demonstration, the internships will address the following questions :

- Which solvent systems should be used for the electrochemical characterization of organic explosives to ensure sufficient solubility and to facilitate the electrochemical processes? Can organic solvents or solvent mixtures be used?
- Can organic nitro-based explosives (nitro aromatics, nitrate esters, nitrate amines) electrochemically be detected (explosive present?), classified (which type of explosive?) and identified (is differentiation within a type possible?)
- Can the reduction of nitrate to amine as reported in literature be confirmed and are intermediate species formed in this process?

- How does the electrochemistry progress over the multiple nitrate groups in a nitro-based explosive?
- Are organic peroxide-based explosive electrochemically active and can they be detected and identified with electrochemistry? If so what electrochemical reactions are involved and which species are formed?
- Can inorganic explosives (black powder, flash powder, ammonium nitrate, urea nitrate) be detected, classified and identified?
- More specifically, can a simple electrochemical test be developed to rapidly discriminate between black powder (legal fireworks) and flash powder (illegal fireworks)?
- More specifically, can a simple electrochemical test be developed to rapidly discriminate between ammonium nitrate and urea nitrate?
- Can typical military and commercial explosive materials including explosive mixtures and additives such as plasticizers (e.g. C4, Semtex) yield a characteristic electrochemical profile that would allow product recognition?
- Are there any common, regularly found materials and products that could yield a false positive result for the electrochemical explosive characterization?

REQUIRED/RECOMMENDED EXPERTISE

Basic understanding on forensic chemistry, analytical chemistry and electrochemistry is recommended.

REFERENCES

- 1) Yu *et al*, Recent developments in the electrochemical detection of explosives: Towards field-deployable devices for forensic science, *Trends in Analytical Chemistry*, 97(2017)374-384
- 2) De Jong *et al*, Tackling Poor Specificity of Cocaine Color Tests by Electrochemical Strategies, *Analytical Chemistry*, 90(2018)6811-6819

