Best Wastes & Resources Management Presentation at Environ 2021

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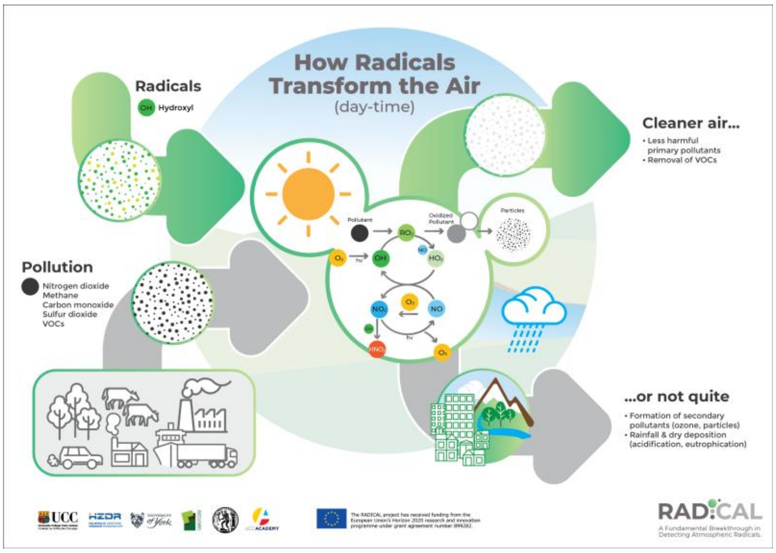
Electrical Detection of Atmospheric Radicals



Air quality and climate change are among the biggest societal challenges that we face today. According to World Health Organization, air pollution is the single greatest environmental risk. An estimated 7 million people globally die prematurely each year due to air pollution. The estimated economic costs of air pollution in the Europe are well over €20 billion a year. Atmospheric free radicals, particularly hydroxyl (OH) and nitrate (NO_3), are the drivers of chemical processes that determine atmospheric composition and thus influence local and global air quality and climate.

Therefore, detecting and understanding the behaviour of radical species in the atmosphere is important. Radicals are challenging to detect because of their low mixing ratios, short lifetimes (only 1 second for OH) and fast surface losses during sampling. Current techniques for measuring radicals, which are based on spectroscopic and mass spectrometric methods, are technically complex, cumbersome and expensive. As a result, the measurement of atmospheric radicals is far from routine and only a few research groups worldwide can perform them in a very limited number of geographic locations.

The motive of my Ph.D. is to develop new sensors that can detect radicals through an innovative technique. My Ph.D. is a part of EU-funded project called RADICAL (radical-air.eu), with six different partner institutions across Europe and coordinated by Professor Justin Holmes at UCC. The sensor platform will be built from silicon junctionless nanowire transistors (JNTs), which is a technology first developed in Cork. These transistors will be coated with an organic layer to selectively trap the radicals. When a radical interacts with the organic layer, it will change the electric signal from the JNT, which will be measured and analysed using machine learning. This is similar to how an electronic nose works to electrically detect gases. My group at UCC has previously used this type of electronic nose sensor to detect streptavidin protein in liquids (*Georgiev, Y. M. et al., Nanotech., 2019, 30, 324001*). But this will be the first time that these JNT sensors are used for detecting gases, in the form of atmospheric radicals. We will test the sensors in the new atmospheric chemistry chambers at ERI and UCC.

The sensors will be a great breakthrough in atmospheric monitoring. Once developed, the sensors could be deployed at air monitoring stations around the world to transform the way we measure air quality. Better detection of atmospheric radicals will help us to better understand air quality models, and therefore better predict air pollution levels. This will lead to improved human health and a cleaner environment. There are also several spin-off applications for these low-cost sensors. They can be further adapted into other areas such as measurement of atmospheric pollutants (NH_4, NO_2 and SO_2), and potentially be used to detect free radicals in human body and applications in food security and surveillance.