School of Physical Sciences Seminar

Title: Plasma-based conversion: a focus on Nitrogen fixation

Speaker: Dr Sean Kelly (University of Antwerp), will speak on the topic of Plasma-based conversion: a focus on Nitrogen fixation

Abstract: Artificial nitrogen fixation, in the production of fertiliser, is a cornerstone of modern civilisation and sustains much of the world's growing population. The activity is, however, a large contributor to anthropogenic climate change. Plasma-based gas conversion, driven by renewable sourced electricity, shows great potential for enabling a carbon-free alternative.
In this work, we demonstrate energy-efficient NOx formation from air and N2/O2 mixtures, in a plasma filament isolated at the center of a quartz tube operating at atmospheric pressure, using a swirl gas flow. The electrode-free ignition provides a significant advantage, given the reduced energy losses to the walls, which limits damage, especially at higher powers, with the key benefits of a prolonged reactor lifetime and no metal contamination (which is potentially detrimental to soil and ecosystems in agriculture applications). NOx production, via an enhanced Zeldovich mechanism, is found to scale efficiently with gas flow rate and power. For relatively high flow rates (i.e., 20 L/min), increasing MW power (up to $\sim$1 kW) leads to the highest NOx production ($\sim$3.8%), as well as minimum energy cost ($\sim$2 MJ/mol), giving the best cost-conversion metric for this work. This energy cost is the lowest reported up to now in literature for atmospheric pressure plasmas. The experiments are supported by chemical kinetics modeling, which reveals that the higher flow rate reduces the time available for the back reactions, explaining the better performance. Joule, 5, 11, (2021). https://doi.org/10.1016/j.joule.2021.09.009

Everyone welcome!

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