THE UNIVERSITY of York

# Mark Christie PhD Scholarship in Low Temperature Plasma Science 2018

## Low temperature plasma induced $CO_2$ conversion for green value-added chemical delivery and energy storage

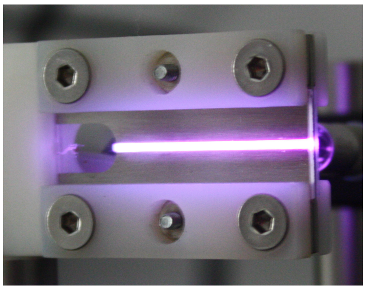
Supervisor: Professor Timo Gans

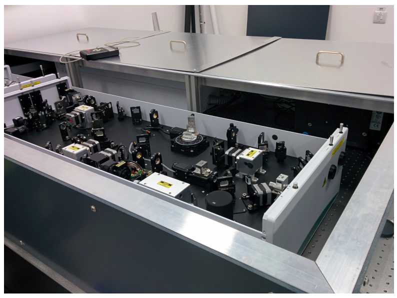
This multi-disciplinary project offers students the opportunity to carry out postgraduate research at the interface of physics and chemistry. The student will be based in the York Plasma Institute and will have access to a wide range of state-of-the-art facilities in the York Plasma Institute Laboratories.

Our previous and ongoing research in this area has already shown the extraordinary potential of low temperature plasma to efficiently convert $CO_2$ (a waste product) into CO which is a valuable building block for the chemicals industry. CO is an inherently toxic gas, so a low temperature plasma based process for its in situ generation as and when required from relatively non-toxic $CO_2$ offers a green approach to the use of CO.

Non-equilibrium atmospheric pressure plasmas offer an attractive technology for converting greenhouse gases into valuable chemical products. This is a particularly promising route for versatile energy storage in renewable energy power plants, exploiting solar or wind energy, towards a $CO_2$ neutral energy economy. This project will focus on efficient conversion of $CO_2$ to CO and $O_2$, using low-temperature atmospheric pressure plasmas. While efficient conversion has already been empirically demonstrated, the fundamental mechanisms of the non-equilibrium chemical kinetics are complex, nonetheless crucial to lift this technology towards a new generation of chemical processing. Reaction and conversion pathways critically depend on the non-Maxwellian electron dynamics on nanosecond timescales and associated energy deposition through dissociation and rotational-vibrational molecular excitation processes. These processes are key for tailored properties since the non-equilibrium electron induced chemical pathways allow superior efficiency over non-selective energy deposition in classical thermal chemistry. The combination of our recently developed control strategies for tailored electron dynamics and our advanced pico- and nanosecond optical diagnostic techniques for electron properties and reactive species analysis are unique worldwide. Together with our advanced multi-scale computational techniques for the chemical kinetics we are ideally positioned to lead this newly emerging field with global impact.

In addition to optimising and studying the plasma used to convert $CO_2$ into CO, the student will also be able to investigate the utilization of the produced CO as a chemical reagent. Whilst many catalytic reactions of CO are already well known, these have been carried out using ultra-pure CO. The CO produced by a low temperature plasma will inevitably contain impurities (oxygen, ozone etc.) and the effect of these on the catalyst and reaction needs to be determined.



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