Report for CCR

Methane oxidation and NOx conversion project

Currently in my second year,I am a Natural Sciences student studying at Girton College,Cambridge. Within Natural Sciences, I am particularly drawn to chemistry because of its wide applications in environmental studies and its crucial role in efforts to mitigate climate change. With growing concern over global warming, I spent my summer investigating potential solutions to reduce atmospheric pollutant emissions—major drivers of climate change—including nitrogen oxides (NOx), methane (CH_4), and carbon dioxide (CO_2). My work focused on exploring catalytic methods for converting and capturing these pollutants.

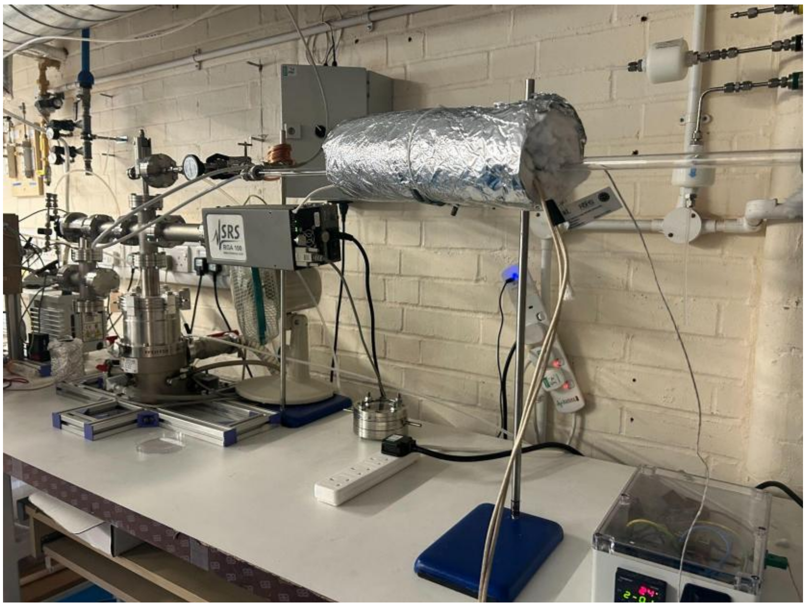
Nitrogen oxides, methane, and carbon dioxide are key contributors to environmental and health problems. NOx gases degrade air quality by forming smog and ground-level ozone, which irritate the lungs and damage ecosystems. Methane is a highly potent greenhouse gas, trapping far more heat per molecule than CO_2, though it remains in the atmosphere for a shorter time. Carbon dioxide, while less potent per molecule, is the most significant long-term driver of climate change because of its high concentration and persistence. Together, these gases intensify global warming, worsen air quality, and disrupt natural systems. Reducing their atmospheric concentrations is therefore essential to combating climate change.

During my project, I focused primarily on the possibilities and limitations of methane oxidation using photocatalysis under the supervision of Tzia Ming Onn. Methane is notoriously difficult to oxidise because of its non-polar nature, which renders many charge-based catalytic interactions ineffective. Photocatalysis offers an attractive alternative: energy delivered by UVC light generates high-energy radicals capable of reacting with methane and promoting its conversion. Building on relevant post-doctoral research in the group, my investigation addressed one important concern—release of tropospheric ozone during high-energy radical formation—by using UV light of longer wavelength in combination with silver-based catalysts.

Another major aspect of my project was the conversion of NO_x to ammonia, a valuable raw material widely used in industries such as fertiliser production. Through an extensive literature review, I synthesised and characterised a range of catalysts aimed at achieving high conversion rates. Spectrometry-based experiments were performed to evaluate the feasibility of NO_x conversion to ammonia, and the results demonstrated the promising potential of this approach. However, further research is needed to improve catalyst selectivity and develop more refined experimental setups that more accurately model real-world atmospheric conditions. As a side investigation, I also synthesised novel imine-functionalised catalysts, which exhibited encouraging properties for CO_2 absorption and desorption under white-light illumination.

This eight-week project was an invaluable opportunity to gain hands-on research experience as an experimental scientist. I would like to express my sincere gratitude to my supervisor, Tzia Ming Onn, for his exceptional guidance, patience, and expertise, which ensured not only the successful completion of the project but also made my time in the laboratory thoroughly enjoyable. I am equally grateful to the members of the Onn Group, especially

Ning Wang, whose assistance was instrumental to the progress of this work. This experience has allowed me to apply my skills to real-world problems, broaden my academic knowledge, and develop both technical and troubleshooting abilities.Importantly, it has also deepened my appreciation for the vital contributions of researchers and organisations such as CCR worldwide in mitigating human impacts on the climate by minimising pollutant emissions.



Picture: NOx removal experimental set up

Picture: UVC light/ reaction chamber for Methane Oxidation