Plasma-catalytic synthesis of platform chemicals and fuels from CO_2

Xin Tu
Department of Electrical Engineering and Electronics, University of Liverpool, Liverpool, L69 3GJ, UK

Carbon dioxide issue has recently become the focus of global attention because of the position of CO_2 as the primary greenhouse gas and the implication of its emissions on the problem of climate change and global warming. The chemical transformation of CO_2 into platform chemicals and fuels will become a key element of sustainable low-carbon economy. CO_2 will be a strategic molecule for the progressive introduction of renewable energy sources into the chemical and energy chain and be part of the portfolio of critical technologies for curbing CO_2 emissions. Non-thermal plasmas offer an attractive and promising alternative for the synthesis of fuels and chemicals from low value feedstock CO_2 - especially when combined with catalysis, providing a unique way to enable thermodynamically unfavourable reactions to occur at atmospheric pressure and low temperatures. We have developed different plasma sources (dielectric barrier discharge and gliding arc) for the activation of CO_2 into platform chemicals and fuels (e.g. methanol, formaldehyde and acetic acid) at atmospheric pressure and room temperature. A range of catalysts including supported bi-metallic catalysts and promoted catalysts have been developed and investigated in the plasma-catalytic reactions. The integration of the plasma and catalysts clearly exhibits a significant low temperature synergistic effect, showing both the conversion of CO_2 and the selectivity/yield of target products are enhanced compared to sum of the performance in individual reaction using plasma-alone or catalysis-alone under the same conditions.