**Alternative pathways for the conversion of carbon dioxide into fuels**

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The valorisation of carbon dioxide to value added products, such as methane and formate, provides a route to mitigate anthropogenic emissions to the atmosphere whilst simultaneously producing valuable fuels. Conventional conversion of carbon dioxide, via the Sabatier reaction, requires large energy inputs in the form of heat (typically >400oC). To overcome this, we have examined a variety of pathways for the conversion of carbon dioxide to fuels, including electrochemically, light-enhanced thermal methanation as well plasma-catalytic carbon dioxide methanation. To minimize energy inputs, and make use of our vast solar resources, the light-enhanced thermal methanation work focused on designing materials which are able to utilise sunlight (both full spectrum and visible light) to reduce temperature requirements.

In the plasma-catalytic methanation of carbon dioxide, a dielectric barrier discharge plasma is generated resulting in the activation of the reactant gases, as well as the catalyst. This study demonstrated plasma-driven CO2 conversions approaching the reaction equilibrium with high methane yields even at low temperatures (150 oC). With extensive pre- and post-catalyst charaterisation as well as in-situ optical emission spectroscopy, and in-situ atomic pair distribution function generated from high energy X-ray diffraction data, a comprehensive understanding of the complex and interdependent plasma/catalyst synergy was be generated.

Ultimately, this work provides a step toward understanding the complex interactions within hybrid catalytic systems for the conversion of carbon dioxide into fuels.