Plasma-enhanced catalysis: An emerging technology for CO_2 conversion

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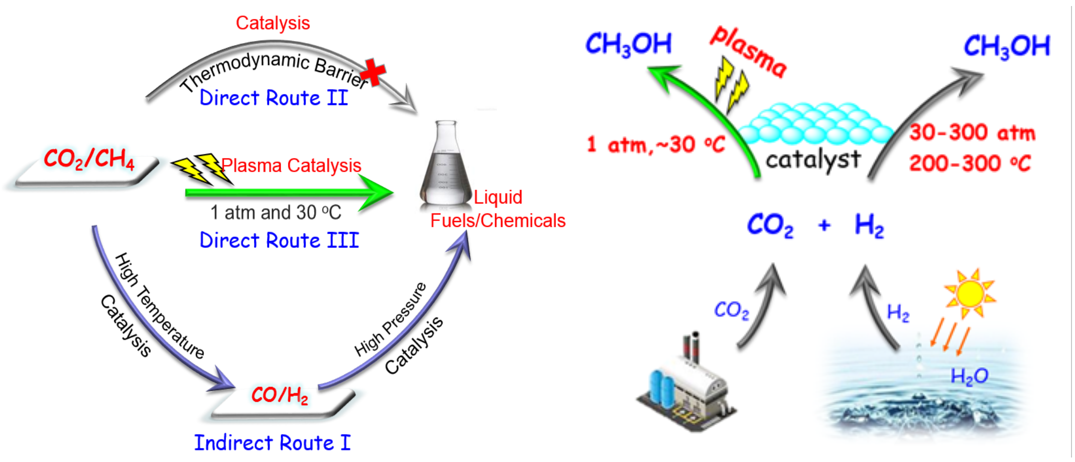
The chemical transformation of CO_2 into platform chemicals and synthetic fuels has attracted significant interest. However, the activation of CO_2 remains a great challenge as CO_2 is a thermodynamically stable molecule and requires a significant amount of energy for its activation. Non-thermal plasmas offer a promising and attractive alternative for CO_2 activation, providing a unique route to enable thermodynamically unfavorable reactions to proceed at ambient conditions. The combination of non-thermal plasma and heterogeneous catalysis has great potential to generate a synergistic effect from the interactions between the plasma and catalysts, which can activate catalysts at low temperatures and improve the activity and stability of the catalysts, resulting in the remarkable enhancement of conversion, selectivity and yield of end-products, as well as the energy efficiency of the process.

We have developed a novel plasma-catalytic process for room temperature and ambient pressure hydrogenation of CO_2 (with either H_2 or CH_4) into value-added liquid fuels and chemicals (e.g., methanol, ethanol and acetic acid) in a dielectric barrier discharge reactor (Fig. 1), to avoid using conventional high temperature and/or high pressure multi-step catalytic processes [1-2]. The combination of plasma and catalysts (e.g., Cu/Al_2O_3) in this process has shown a synergistic effect and can be used to tune the distribution of different liquid products. This is a major breakthrough process that has great potential to deliver a step-change in future methane activation, CO_2 conversion and chemical energy storage, to tackle the challenges of global warming and greenhouse gas effect.



(a) (b)

Fig. 1 Scheme of CO_2 activation via (a) dry reforming; (b) CO_2 hydrogenation

[1] Y. X. Zeng, L. Wang, C. F. Wu, J. Q. Wang, B. X. Shen, and X. Tu, Appl. Catal. B: Environ., **224**, 469 (2018).
[2] L. Wang, Y. Yi, C. Wu, H. Guo, and X. Tu, Angew. Chem. Int. Ed., **56**, 13679 (2017).
[3] L. Wang, Y. Yi, H. Guo, and X. Tu, ACS Catal., **8**, 90 (2018).

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