

## Investigation of synergic response on low temperature plasma catalytic C1 conversion for the production of platform chemicals

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CH<sub>4</sub>, the major feedstock in platform chemicals synthesis and hydrogen production, has gradually drawn energy safety and environmental concerns in fossil fuel utilization owing to its rapid increase in global demand [1]. Under the goal of carbon neutralization, it is an urgent need to develop environmental-friendly approaches of in-situ CH<sub>4</sub> conversion to platform chemicals at mild condition with high energy and resources utilization efficiency.

The Non-thermal plasma (NTP) technology is highlighted as a promising new frontier to overcome the above challenges associated with its non-equilibrium characters, it could be easy to activate the chemically inert gases (CH<sub>4</sub>, CO<sub>2</sub>, etc.) at room temperature and atmospheric pressure with the energetic electrons. Based on application background of the distributed clean energy and natural gas in-situ utilization, this talk focuses on the plasma enabled C1 conversion for value-added chemicals. Several plasma sources are employed to directly convert the CH<sub>4</sub> into platform chemicals (e.g. syngas, CH<sub>3</sub>OH, C<sub>2+</sub> alcohols) with specialized plasma reactor.

Firstly, this talk aims at the regulating effects of pulsed parameters on the discharge properties, transient species evolution and the gaseous products distribution in plasma enabled CH<sub>4</sub> dry reforming process, while the maximum conversion of CH<sub>4</sub> and CO<sub>2</sub> could respectively arrive at 39.6% and 22.9%. The result showed that short pulse rise & fall times promoted CH<sub>4</sub> and CO<sub>2</sub> conversions, as well as the energy conversion efficiencies [2].

Secondly, this talk will introduce a promising plasma approach for the partial oxidation of CH<sub>4</sub> into hydrogen and value-added oxygenates (alcohol, acetic acid, and aldehydes) using the dielectric barrier discharge, achieving the maximum H<sub>2</sub> selectivity (46.3%) and total liquid selectivity (76.8 %) under different operating conditions [3]. An adjustable pulsed power source was employed to directly convert CH<sub>4</sub> into hydrogen and liquid chemicals with the addition of specialized gaseous/aqueous contents. Thus, the parameterized pulsed discharge allowed us to subtly customize the oxidation within the micro time scale, moving toward the performance limit of this promising process which was

rarely explored before. The investigation and decoupling of plasma-catalysis synergic effects is another main key scientific problem. Based on the experimental evaluation of plasma-enabled catalytic system, high-resolution spectroscopic techniques and theoretical calculations are employed to elucidate the interface regulation mechanism for directional conversion and mass-transfer, for the further process optimization and realize the in-situ high-value utilization of CH<sub>4</sub>.

At last, we would like to introduce our work on the single step synthesis of C2-C4 alcohols by plasma enabled CH<sub>4</sub>-CH<sub>3</sub>OH conversion [4]. Here, an innovative synthesis of higher alcohols from CH<sub>4</sub>-CH<sub>3</sub>OH was driven by a highly flexible nanosecond pulsed plasma. Experimental results showed that the products distribution was strongly correlated with the electric field variation and reactants composition, and the maximum conversion of CH<sub>4</sub> (35.9%) and CH<sub>3</sub>OH (77.4%) were obtained at the CH<sub>4</sub>/Ar ratio of 1:2. optical diagnostics were used to obtain the active species distribution and integrated insights into the C-C coupling of higher alcohols generation.

### References

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