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EFFECTIVE METHANE CONVERSION BY NEGATIVE NANOSECOND REPETITIVELY PULSED DISCHARGE

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Conversion of methane (CH4) to value-added chemicals and fuels by non-thermal plasmas is a solution for effective energy utilization in the 21st century. In this paper, CH4 conversion by a nanosecond repetitively pulsed (NRP) discharge is studied. Negative NRP discharge can realize various discharge regimes, namely corona discharge, filamentary discharge and spark discharge, in a needle-plate reactor1,2. In corona discharge, the plasma is quite diffusive, but the input energy is so low that only trace hydrogen is found in this regime. The main products of filamentary discharge are H2, and C2H6 with hydrogen selectivity of 40% and 12%, while the CH4 conversion rate is 13%, As for the spark discharge, the input energy is much more energetic that the main products become H2, C2H2 and amorphous soot. The CH4 conversion rate is 77%, and the selectivity of C2H2 is 6%. The ultrafast ICCD images and optical emission spectroscopy were recorded to study the discharge mechanism and plasma chemistry. It is found that short pulse width could inhibit the growth of bright spots around the electrodes, prevent the transition between filamentary discharge and spark discharge, and thusly control the input energy smoothly. The CH, C2, and Hα are the highest emission spectra profiles in these discharge regimes, respectively. The appearance of C+ in the spark discharge accounts for the dramatic increase of current and temperature. The gas temperature estimated by the rotational temperature of CH(A-X) and C2 swan band are 700 K, 1000 K and 1800 K, respectively, which suggests the thermal reactions play an important role in controlling the final products.

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