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# Direct conversion of methane by an atmospheric-pressure dielectric barrier discharge (DBD) microplasma

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***Abstract*—Methane (CH4) is an abundant resource commonly burned for heating or converted into more useful fuels for energy and chemical applications. CH4 is typically converted by reacting with steam (H2O) or carbon dioxide (CO2) in a high temperature catalytic process. Alternatively, it is desirable to directly convert CH4 to hydrogen (H2), acetylene (C2H2), and other hydrocarbons without producing oxygen, H2O, carbon monoxide, CO2, and other oxygen containing molecules. However, dissociation of CH4 requires very high temperatures and catalytic cracking leads to significant coking. Alternatively, electrical discharges can provide the sufficient energy required to break the CH4 molecule and can address coking by producing soot in the gas phase, which may be easier to separate without shutting down the reactor. Here, we present results for dissociation of CH4 in an atmospheric-pressure dielectric barrier discharge (DBD) microplasma. The microplasma is formed in a confined reactor geometry, inside a quartz capillary between a copper ring surrounding the reactor and a tungsten wire in contact with the gas. The plasma is powered by coupling 20-60 kHz AC voltage to the copper electrode. At this frequency, the plasma can be ignited and stably formed in a pure flow of CH4. Steady-state products are monitored by gas chromatography with a thermal conductivity and flame ionization detector (Shimadzu, Model GC-2014). We find conversions of up to 50% of CH4 to H2, C2H2, C2H4, C2H6, and other higher order hydrocarbons. The yield and product distribution are found to strongly depend on the residence time of CH4 in the reactor. We hypothesize that the microscale geometry allows residence time to control reaction selectivity and soot particle nucleation.**