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1P55 - Pulsed power-induced CO2 dissociation for CO production

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Carbon dioxide CO_2, as thermodynamically stable end product of fossil fuel based combustion, is an interesting source for carbon monoxide CO, if a sustainable energy source is used. CO is a major precursor in chemical synthesis, e.g. Fischer-Tropsch based CO hydrogenation to synthetic hydrocarbons and future fuels.

In this study, pulsed power technology has been applied for generating a non-thermal plasma for CO_2 dissociation; the CO_2 average bond dissociation energy is 8.3 eV. A capacitor-spark gap pulsed power source has been utilized, typically delivering 200 mJ pulse energy (at repetition rates up to 100 Hz) to a concentric wire-cylinder electrode geometry in an atmospheric pressure and ambient temperature operated reactor. Power-to-gas coupling has been studied by varying gas flow and pulse repetition rates. CO_2 conversion and CO production efficiencies have been determined as a function of the energy density, for plasma batch operation of CO_2 mixtures with nitrogen, argon or helium.

CO_2 conversion has appeared to be most favorable using Ar as buffer gas. This is explainable by the average metastables energy which decreases according to the order He>Ar>N_2, combined with the assumption that He metastables production under the applied plasma conditions is less favorable. Although CO_2 conversion levels increase with energy density, also the probability of CO_2 back oxidation increases, when oxygen is not removed from the system. Additionally, it has appeared that the plasma provides enough energy to even split CO with a bond dissociation energy of about 11.2 eV; in other words, carbon deposition has been observed.

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