Workshop »Coatings for Energy Technologies«

Carbon dioxide conversion in an electron beam sustained atmospheric pressure plasma

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Carbon dioxide (CO_2) conversion processes will play an important role in closed carbon cycles for net zero carbon emission economies in the future. Especially industries, which cannot be electrified or powered by hydrogen will have huge demands of sustainably produced high value chemicals such as methanol and e-fuels, in the production of which plasma-based conversion technologies can play a crucial role.

Due to their high process flexibility, selective energy transfer, and non-dependence on catalyst materials, non-equilibrium plasmas are well suited for conversion processes like CO_2 splitting, dry methane reformation or CO_2 hydrogenation. Despite their numerous technical advantages,

they are not yet economically feasible in terms of CO_2 conversion, since they struggle to simultaneously achieve high energy efficiency and high conversion degree for the splitting of CO_2 molecules and are often bound to sub-atmospheric pressure [1].

These issues can be addressed by utilizing a non-self-sustained plasma, characterized by an electron beam which sustains a plasma created by low electric fields. This hybrid approach potentially allows to efficiently transfer energy from the plasma mainly into vibrational dissociation pathways by working at low reduced electric field strengths (about 20 Td), while sufficient ionization in the plasma is ensured by the electron beam.

Based on this principle a reactor for gas conversion processes was developed and taken into operation. First plasma characterization experiments were performed and different operation regimes are discussed with regard to energy deposition into the plasma and conversion potential.

1. Snoeckx R, Bogaerts A (2017) Chem Soc Rev 46(19):5805–5863. doi:10.1039/c6cs00066e