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Plasma-based CO_2 Conversion

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Abstract: Sustainable energy generation by means of wind or from solar radiation through photovoltaics or concentrated solar power will continue to increase its share of the energy mix. Intermittency due to e.g. day/night cycle, regional variation in availability, and penetration of sustainable energy into sectors other than electricity such as the chemical industry necessitates means of storage, transport and energy conversion on a large scale. A promising option is the synthesis of chemicals and artificial fuels using sustainable energy. A truly circular economy requires that the raw materials are the thermodynamically most stable ones such as CO2 and N2, and probably even CH4. In this contribution it will be highlighted how plasma chemistry can potentially combine compatibility with e.g. intermittency and localized production to activate these molecules with maximum energy efficiency. Starting from a prevalent picture within the field of preferential vibrational excitation (causing inherently strong out-of-equilibrium processing conditions that achieve selectivity in the reaction processes) that may intensify chemical reactions, it will be shown how high power densities create fast dynamics that can be exploited in thermal routes. Examples will be discussed that connect to carbon capture and utilization, to nitrogen fixation, and to carbon circularity.

Short Bio

Gerard van Rooij is full professor in plasma chemistry at Maastricht University and in sustainable plasma chemistry at the Eindhoven University of Technology. He obtained his MSc in Physics at the Eindhoven University of Technology (specialization Plasma Physics) and received his PhD degree at the University of Amsterdam for his research on macromolecular mass spectrometry that he performed at AMOLF. As a project leader for low temperature plasma physics, he pioneered the scientific basis of the unique devices for plasma surface interaction studies within DIFFER and participated in the research programs of the major international facilities for fusion research to study the role of plasma chemistry therein. Since 2012, he researches plasma activation of chemical reactions to aid storage of sustainable energy in chemical potential energy for its integration in other sectors such as transport and chemical industry, work that he currently continues part-time at DIFFER. In 2020, he was appointed to head of the Circular Chemical Engineering department. From his role at Maastricht, Van Rooij participates in various program lines connected to the Brightsite consortium that aims at providing climate neutral solutions to the chemical industry.