Electrification of chemical industry: a key role for plasma chemistry

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 CO$_2$ and N$_2$. 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, essentially due to preferential vibrational excitation (causing inherently strong out-of-equilibrium processing conditions that achieve selectivity in the reaction processes). Examples will be discussed of research carried out at DIFFER to ultimately enable a scale up to chemical industrial applications.