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The hot topic of cold plasma: CO2 conversion into value-added compounds

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Plasma-based CO_2 conversion is gaining increasing interest [1]. To improve this application in terms of conversion, energy efficiency and product formation, a good insight in the underlying mechanisms is desirable. We try to obtain this by computer modelling, supported by experiments. We will first provide a brief overview of the state of the art in plasma-based CO_2 (and CH_4) conversion, with different types of plasma reactors. Subsequently, we will present some recent results obtained in Antwerp in this domain, including experiments and modeling for a better understanding of the underlying mechanisms. This includes modeling the plasma chemistry as well as the reactor design, in different types of plasma reactors commonly used for gas conversion, i.e., dielectric barrier discharges (DBDs), gliding arc (GA) discharges, microwave (MW) plasmas and atmospheric pressure glow discharges (APGDs). For the plasma reactor design, we use 2D or 3D computational fluid dynamics modelling [2]. For the plasma chemistry, we make use of zero-dimensional chemical kinetics modeling, which solves continuity equations for the various plasma species, based on production and loss terms, as defined by the chemical reactions [3]. We will show the role of vibrationally excited CO_2 levels for energy-efficient CO_2 conversion, as well as the role of thermal conversion in warm plasmas (such as GA and MW plasmas) and quenching after the plasma. We will also show how the performance in CO_2 conversion and energy efficiency can be improved in novel reactor designs, developed based on CFD modeling [4,5]. [1] R. Snoeckx and A. Bogaerts, *Chem. Soc. Rev.* 46, 5805-5863 (2017). [2] A. Bogaerts, A. Berthelot, S. Heijkers, St. Kolev, R. Snoeckx, S. Sun, G. Trenchev, K. Van Laer and W. Wang, *Plasma Sources Sci. Technol.* 26, 063001 (2017). [3] A. Bogaerts, C. De Bie, R. Snoeckx and T. Kozák, *Plasma Process. Polym.* 14, e1600070 (2017). [4] G. Trenchev, A. Nikiforov, W. Wang, St. Kolev and A. Bogaerts, *Chem. Eng. J.,* **362**, 830-841 (2019). [5] G. Trenchev and A. Bogaerts, *J. CO_2 Utiliz.,* **39**, 101152 (2020).