Abstract Submitted
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Student Excellence Award Finalist:Reconsidering the importance of vibrations and translations:a new perspective on efficient plasma activation of CO_2 A.J. WOLF, F.J.J. PEETERS, P.W.C. GROEN, T.W.H. RIGHART, W.A. BONGERS, M.C.M. VAN DE SANDEN, DIFFER, Eindhoven, The Netherlands — Vibrational non-equilibrium conditions are frequently put forward as a prerequisite for energy-efficient chemical conversion of CO_2 in moderate to high-pressure plasma sources. The merits and mechanisms of non-equilibrium plasma reactivity are, however, still subject to debate as key literature results remain to be reproduced experimentally. Furthermore, the consequences of pressure-related discharge contraction and gas-dynamic transport are often disregarded, despite being essential in a comprehensive interpretation of plasma-chemical experiments. In this contribution, plasma contraction and transport are consolidated for the first time using 2D thermal chemical kinetics modeling of the flow reactor. By incorporating experimentally obtained non-uniform power deposition profiles, gas temperatures, and approximations for axial and radial transport, a holistic but straightforward description of the CO_2 microwave plasma emerges: we find that the reactor performance is adequately described by plasma-induced thermal chemistry. However, the predominance of turbulent transport of plasma species towards colder regions may induce strong (vibrational) non-equilibrium conditions in the plasma periphery, irrespective of the quasi-thermal nature of the plasma itself. Leveraging the reactivity of O radicals with CO_2 in a non-equilibrium plasma periphery may make possible energy efficiencies of over 70%, warranting further investigation into post-discharge kinetics and transport.

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