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Plasmolysis for efficient CO2-to-fuel conversion

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The strong non-equilibrium conditions provided by the plasma phase offer the opportunity to beat traditional thermal process energy efficiencies via preferential excitation of molecular vibrational modes. It is therefore a promising option for creating artificial solar fuels from CO_2 as raw material using (intermittently available) sustainable energy surpluses, which can easily be deployed within the present infrastructure for conventional fossil fuels. In this presentation, a common microwave reactor approach is evaluated experimentally with Rayleigh scattering and Fourier transform infrared spectroscopy to assess gas temperatures and conversion degrees, respectively. The results are interpreted on basis of estimates of the plasma dynamics obtained with electron energy distribution functions calculated with a Boltzmann solver. It indicates that the intrinsic electron energies are higher than is favourable for preferential vibrational excitation due to dissociative excitation, which causes thermodynamic equilibrium chemistry still to dominate the initial experiments. Novel reactor approaches are proposed to tailor the plasma dynamics to achieve the non-equilibrium in which vibrational excitation is dominant.

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