Master’s Thesis

Investigation of Plasma-based CO$_2$ Conversion for Mars ISRU Applications by Global Modeling

Starting Date: flexible

Motivation:
In-situ resource utilization (ISRU) is believed to play a major role in enabling and facilitating the manned exploration and habitation of Mars and other planets. Especially the conversion of atmospheric CO$_2$ into valuable products and (rocket) fuels is under investigation by relevant actors, like NASA or SpaceX. Besides solid oxide electrolysis (MOXIE on Mars2020), plasma-based carbon dioxide conversion is a promising approach.

At the Institute of Space Systems, in cooperation with the Ruhr-University Bochum, the global plasma model globalKin, developed by Prof. Mark Kushner, is applied to study the process of plasma-based carbon dioxide splitting in the inductive plasma generator IPG4. Due to their volume-averaged nature, global models are capable of simulating an extensive chemistry without the need for thermal equilibrium assumptions.

In this work, an existing CO$_2$ model, built into globalKin, shall be extended by a detailed N$_2$ chemistry set. Subsequently, the impact of nitrogen dilution on the CO$_2$ splitting performance, compared to pure carbon dioxide, shall be elaborated. Finally, the global model shall be applied to an ISRU scenario, reflecting the composition and boundary conditions on the Martian surface.

Task:
- Literature review on existing plasma models and reaction kinetics of CO$_2$ gas mixtures, focusing on Mars atmosphere composition
- Familiarization with the concept of global plasma modeling and the globalKin code
- Implementation of N$_2$ chemistry into the globalKin CO$_2$ model
- Verification of the implementation by comparison with literature results
- Parameter studies on the impact of N$_2$ dilution on the CO$_2$ splitting performance for Mars ISRU applications
- Documentation

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