University of Stuttgart
Institute of Space Systems

Master's Thesis

Investigation of Plasma-based CO_2 Conversion for Mars ISRU Applications by Global Modeling

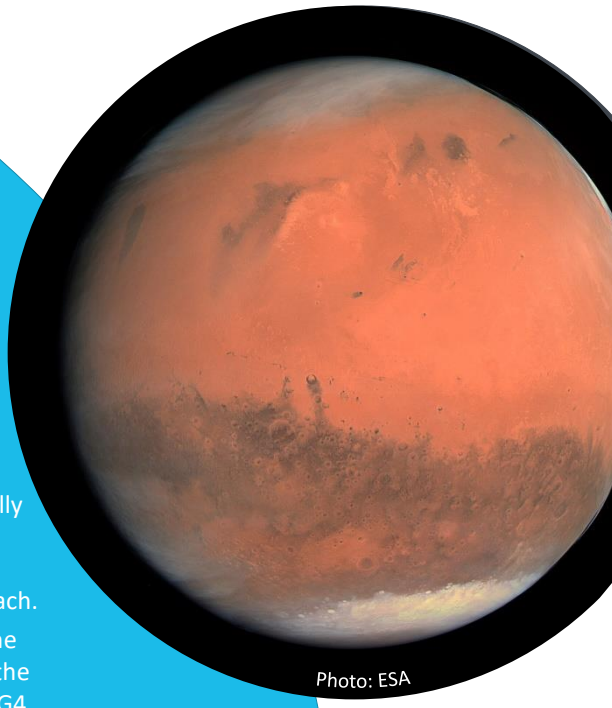
Photo: ESA

Starting Date: October 2023

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

Hendrik Burghaus
Institut für Raumfahrtsysteme
Universität Stuttgart
Pfaffenwaldring 29
70569 Stuttgart

E-Mail: hburghaus@irs.uni-stuttgart.de
Tel.: +49 711 685-62074

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