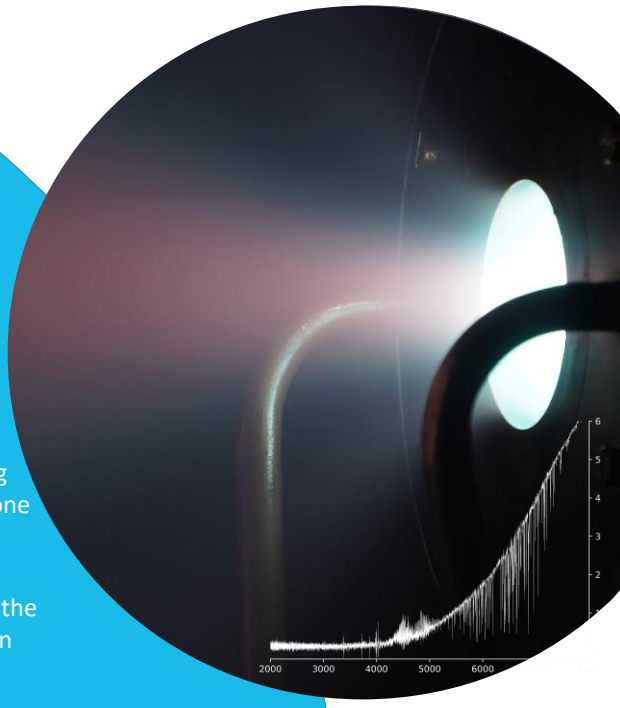
University of Stuttgart
Institute of Space Systems

Master's Thesis

Application of Infrared Spectroscopy for In-Situ Characterization of a CO_2 Plasma in PWK3



Starting Date: April 2023

Motivation:

Carbon capture and utilization (CCU) is believed to play a major role in de-carbonizing industrial processes and mitigating climate change. Plasma-based CO_2 conversion is one promising way of converting carbon dioxide into valuable products or fuels, while allowing for high energy efficiencies.

At the Institute of Space Systems, the plasma wind tunnel facility PWK3, powered by the inductive plasma generator IPG4, is used to study the process of plasma-based carbon dioxide splitting. To better understand the underlying principles it is important to characterize the CO_2 plasma by means of optical and intrusive diagnostics. Infrared spectroscopy is widely applied for the determination of temperatures and particle number densities in atmospheric pressure plasma jets.

In the current work, it shall be investigated, whether Fourier-Transform Infrared Spectroscopy (FTIR) is suitable to measure ro-vibrational spectra of CO2 and CO locally in the supersonic IPG4 plasma jet at reduced pressure. Moreover, the quantification of measurements by spectral simulations shall be covered.

Task:

- Literature review on existing FTIR experiments for high-enthalpy plasma flows
- Familiarization with the fundamentals and application of Fourier-Transform Infrared Spectroscopy
- Design and implementation of a modular optical setup for FTIR emission and absorption spectroscopy at PWK3, based on existing hardware
- Review on suitable FTIR spectra simulation tools for data analysis
- Demonstration of the setup in a plasma wind tunnel experiment
- Analysis of the measurements by spectral simulation
- Documentation

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