# P 19: Atmospheric Pressure Plasmas III

Time: Thursday 17:30–18:15 Location: KH 01.020

P 19.1 Thu 17:30 KH 01.020

**Upscaling Microwave $CO_2$ Plasma Torches: Transitioning to 915 MHz Operation** — •Marc Bresser, Katharina Wiegers, Irina Semjonov, Andreas Schulz, Matthias Walker, and Günter Tovar — IGVP, University of Stuttgart, Germany

The continuous rise in Earth's surface temperature makes a reduction of the emission of climate gasses essential. The chemical industry, as one of the largest emitters of $CO_2$, must find new processes to replace fossil routes with renewable alternatives. A promising approach is to use $CO_2$ as a feedstock and close the carbon cycle. One innovative technology is the activation of $CO_2$ with an atmospheric microwave plasma torch, which produces CO and $O_2$. The produced CO can be used together with green hydrogen to form syngas and to be a feedstock for processes like Fischer-Tropsch. One advantage of the microwave plasma is the flexibility of power, small turn on times, and the use of the fluctuations of renewable intermittent energy sources like wind or solar. This work investigates the upscaling of $CO_2$ splitting with an atmospheric plasma torch from 2.45 GHz to 915 MHz. The process at 2.45 GHz was examined up to 6 kW and gas flow-rates of 74 slm. To improve conversion efficiency, the quenching of the effluent plasma was explored using a gas nozzle and different cooler positions. The cold product gas is analyzed with absorption Fourier-transform infrared spectroscopy and a X-Stream gas analyzer. Based on these findings, a 915 MHz plasma torch was designed and constructed. The first conversions results are presented.

P 19.2 Thu 17:45 KH 01.020

**Using the AD8302 phase detector for power measurements of RF-driven plasmas** — •Steffen Schüttler[1], Michael Roloff[1], Sven Weller[2], Michael Konkowski[2], and Judith Golda[1] — [1]Plasma Interface Physics, Ruhr University Bochum, Bochum, Germany — [2]Chair for Experimental Physics II - Reactive Plasmas, Ruhr University Bochum, Bochum, Germany

The use of reference standards for plasmas in laboratories guarantees reproducible results. By this, plasma processes can be thoroughly investigated, as the results are comparable and the focus is on plasma physics rather than on comparing different plasma sources. This was the idea behind the design of the COST reference plasma jet [1]. However, the measured values for plasma characterisation are still diverse. Some groups measure the dissipated plasma power while others only provide the applied voltage, as proper power measurements require a high-resolution oscilloscope (expensive and not everywhere available) to measure the phase shift between voltage and current. But the applied voltage is an external parameter that provides poor insights into the plasma itself. For example, the dissipated plasma power differs at the same external voltage for different feed gases and reactive admixtures. In this work, we provide a new method that uses the AD8302 phase detector to measure the phase shift between voltage and current of the COST reference plasma jet. This offers an easy-to-implement and low-cost alternative for measuring the dissipated plasma power of RF-driven plasmas such as the COST reference plasma jet.

[1] Golda et al. J. Phys. D: Appl. Phys. 49 (2016) 084003 (11pp)

P 19.3 Thu 18:00 KH 01.020

**Particle Dynamics and Characteristics during In-Flight Iron Oxide Reduction in an Ar-H2 Microwave Plasma** — •Jonas Thiel, Lennart Kulik, Moritz Petersen, Marc Böke, and Achim von Keudell — Experimental Physics II - Reactive Plasmas, Ruhr University Bochum, Bochum, Germany

The climate-neutral production of metallic iron from iron ore is an emerging research topic, as the iron and steel industry is one major emitter of CO2. In this work, an atmospheric argon-hydrogen microwave plasma torch is deployed to investigate the in-flight reduction of iron oxide particles. These plasmas provide fast reaction kinetics, a fine control of energy consumption and promising scale-up options. The experimental setup enables a wide range of operating conditions to optimize the process. OES, XRD and spatially resolved RGB pyrometry using two CCD cameras, complemented by a heat transport model and gas-flow simulation, are applied to evaluate parameter variations and the overall reduction efficiency. The resulting phase compositions of the treated particles are correlated with particle size and process parameters, revealing favorable process conditions. Additionally, we observe significant emission trails from the hot particles in the downstream region, which are caused by friction with the much faster gas flow. These formations, which depend on gas-flow dynamics and the particle surface temperature, provide insight into particle size dynamics and evaporation. Overall, the results indicate the potential of in-flight oxide reduction in atmospheric plasmas while also emphasizing challenges such as particle evaporation and surface coatings.