A COMSOL-based 2D self-consistent microwave plasma model

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Introduction: Microwave plasma technologies are gaining interest for the conversion of CO_2 into value-added chemicals such as CO as they offer high energy efficiency. The goal of this study is to get a better understanding of the effect of the pressure on the microwave discharge. As a first step, the plasma model was developed in argon. A reduced chemistry set for CO_2 plasmas is also being developed based on the set of [1].

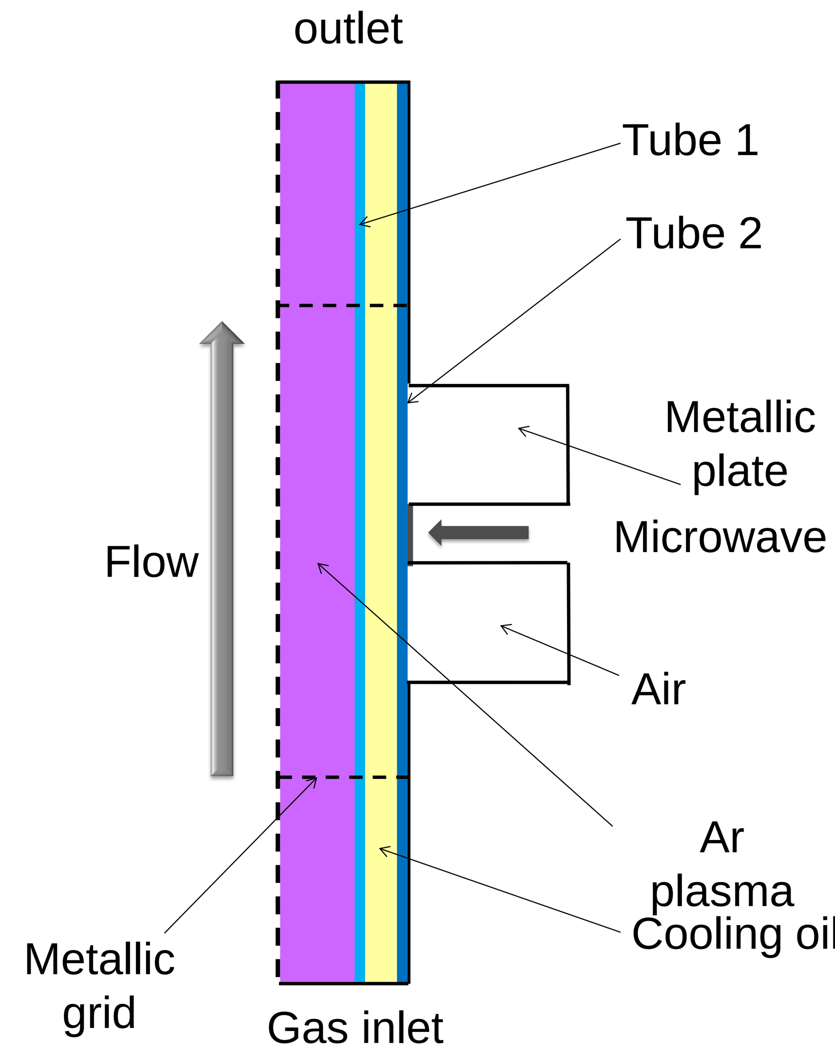

Figure 1. Setup and computational domain

Computational Methods:

- 2D axisymmetric plasma fluid model using Comsol Multiphysics ®
- Plasma, flow, heat and electromagnetic equations solved self-consistently
- 7 species: Ar, Ar4s, Ar4p, Ar_2^*, Ar_2^+, Ar^+, e^-
- 31 reactions (electron impact and heavy particle collisions, radiative transitions)
- EEDF computed using Bolsig+[2]. Transport parameters derived from it.
- Plasma tube inner radius: 7mm; MW frequency: 2.45 GHz, Power: 100 W; Gas flow: 500 sccm

Results: At intermediate pressure (1000 Pa): No radial contraction of the plasma. At atmospheric pressure: Radial and axial contraction of the plasma

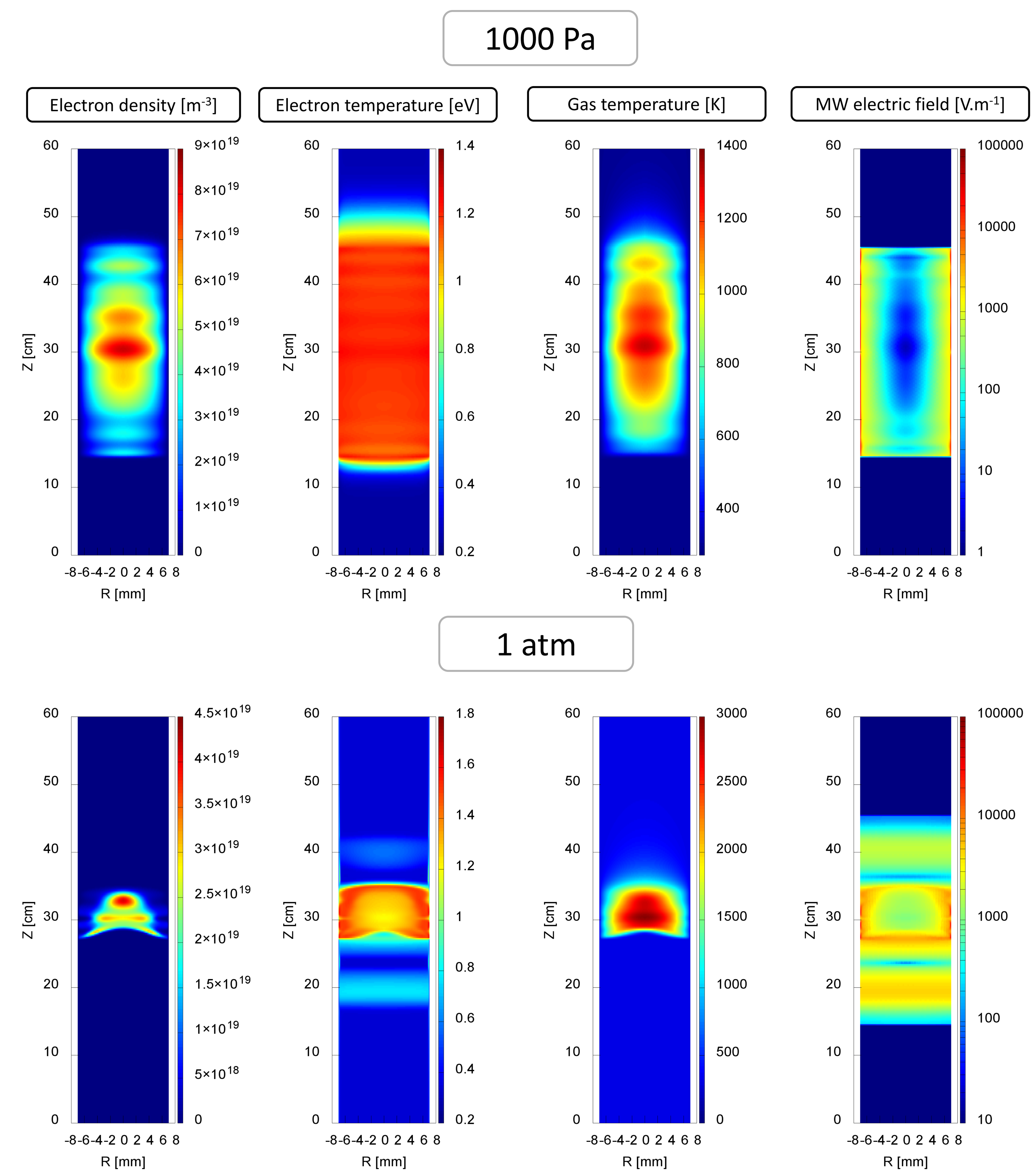

Figure 2. Comparison of the plasma variables at different pressures

Conclusions: The model successfully describes the contraction of the plasma with the pressure increase. In the near future, the CO_2 reduced chemistry set will be used in this model.

References:

1. Kozák T. and Bogaerts A. Plasma Sources Sci. Technol., 23, 045004 (2014)
2. Hagelaar G. J. M. and Pitchford L. C. Plasma Sources Sci. Technol., 14, 4 (2005)

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