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Self-consistent modelling of a linear microwave plasma source

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Microwave plasmas have a wide range of technical applications such as thin film deposition, etching, surface activation or gas conversion. The Duo-Plasmaline, a linearly extended low pressure microwave plasma source, is particularly suitable for such purposes because it can be extended to several meters in length and can produce large volume, high density plasmas.
In this work, the Duo-Plasmaline is investigated for the application in a conceptual recycling system of unburnt fuel (deuterium and tritium) in future fusion devices. Here, the exhaust gas is dissociated by the plasma source so that the atomic and ionic hydrogen isotopes can be separated from other gas species by a metal foil pump via superpermeation.
A self-consistent numerical model of hydrogen plasma from the Duo-Plasmaline was set up to gain insight into the spatial and temporal evolution of the plasma properties and production rates of hydrogen atoms and ions under different operating conditions. An FEM-based fluid approximation for the plasma is used and coupled with the wave equation for the microwave field. A reduced set of reactions, including electron impact collisions, heavy particle reactions and wall reactions, is considered for the plasma chemistry. The distribution of important plasma quantities, such as electron density and temperature, as well as the densities of ionized, excited, and neutral species are studied in terms of gas pressure and microwave power. The simulation results are compared with experimental data.

Keywords
microwave plasma
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