Numerical Simulations of an Atmospheric Pressure Microwave Plasma Torch

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Atmospheric microwave plasma devices are used for various applications like the deposition of coatings and the conversion of waste gases. To understand the complex processes taking place inside these systems it is desirable to develop numerical models in addition to empirical studies. The numerical simulation software COMSOL Multiphysics is used for this purpose.

One objective is the optimisation of the resonator configuration of the investigated microwave plasma torch to ensure the ignition and a continuous operation of the plasma. Eigenfrequency analysis of the resonator geometry consisting of a cylindrical and a coaxial resonator led to an adaption to the applied microwave frequency of 915 MHz.

Another challenge is the handling of gas flows and therefore the optimisation of the gas management. Simulations of the cold gas flow show that an axial gas inlet has to be complemented by a tangential one in order to achieve a rotating flow preventing the hot plasma from touching the confining glass tube.

Since the gas flow in the microwave plasma torch is heated up by the plasma it is also inevitable to study this influence. For these simulations a constant heat source was inserted into a gas flow. The heating power was calculated from the microwave power used in the experiment. The resulting temperature profiles already demonstrate a good agreement with measured values.

Plasma parameters like the electron density and the collision frequency were implemented into the simulation model. The theoretical background is provided by the Drude model which takes the conductivity and the permittivity of the plasma into account.

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