# Characterization of an atmospheric pressure microwave plasma torch for the abatement of halogenated VOC by means of optical emission spectroscopy

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## 1. Introduction

In view of the world climate change the reduction of exhaust gases and the cleaning and purification of waste gases is becoming a more and more important task for enterprises. Especially the abatement of halogenated volatile organic compounds (VOC) which are widely use for etching processes in semiconductor industries and thin-film technologies gains more relevance. The presented plasma source provides an excellent option to conventional thermal combustion processes. The atmospheric microwave plasma source is based on an axially symmetric resonator. Simulations of the electric field distribution resulted in an improved configuration which provides a sufficiently high electric field for plasma ignition and maintaining stable plasma operation [1, 2]. For the characterization of the plasma, optical emission spectroscopy was carried out. Analyses of the abatement of halogenated VOC were performed with $CF_4$ and $SF_6$ containing nitrogen plasmas by using FTIR and mass spectroscopy.

## 2. Optical emission spectroscopy

Optical emission spectroscopy was performed to get information about particle densities and temperatures of ions and neutrals as well as about possible reaction channels. The $A^2\Sigma^+$ - $X^2\Pi_\gamma$-transition of the free OH radical was used to determine a gas rotational temperature of about 3600 K in the center of the resonator. An excitation

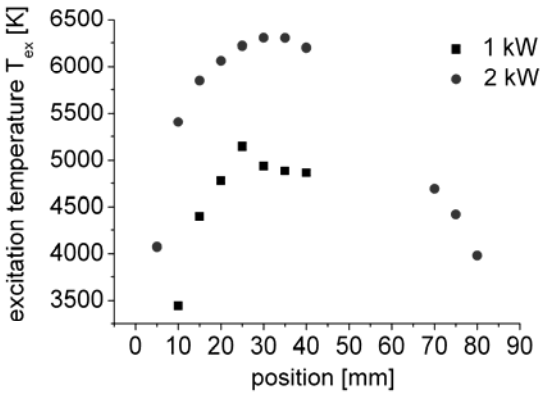


Fig. 1: Excitation temperature $T_{ex}$ profile spatially resolved in axial direction for two different microwave powers.

temperature $T_{ex}$ which gives an estimation of the electron temperature could be measured using two atomic oxygen lines. Fig. 1 shows in axial direction spatially resolved excitation temperature profiles for microwave powers of 1 kW and 2 kW. Further optical emission spectroscopy was carried out at $CF_4$ and $SF_6$ containing nitrogen plasmas to investigate the decomposition of halogenated VOC.

## 3. Abatement of halogenated VOC

The abatement of halogenated VOC was studied by $CF_4$ and $SF_6$ containing nitrogen plasmas. The raw and clean gases were characterized by FTIR and mass spectroscopy. Measurements of the degradation rate of $CF_4$ and $SF_6$

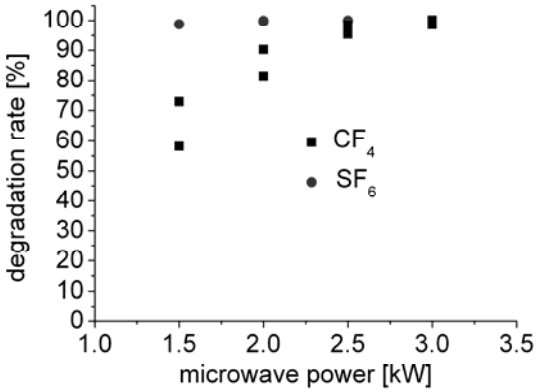


Fig. 2: Degradation rate of $CF_4$ and $SF_6$ for different microwave powers.

showed that a complete decomposition of halogenated VOC using the atmospheric pressure microwave plasma torch is possible. Fig. 2 shows the degradation rate of $CF_4$ and $SF_6$ in the dependence of the supplied microwave power. It can bee seen that 3 kW are sufficient for a degradation rate of 100 %.

## References

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