Comparing surfatron plasmas in Ar with and without SiCl4

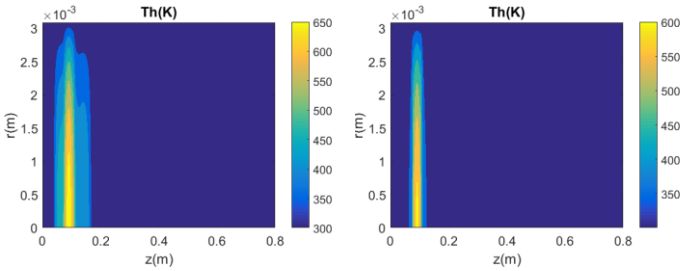
Comparing surfatron plasmas in Ar with and without $SiCl_4$

J.F.J.Janssen[1], J.L.G. Suijker[2], J. Van Dijk[1]
[1] Department of Applied Physics, Eindhoven University of Technology, PO Box 513, NL-5600 MB, Eindhoven, The Netherlands
[2] Philips Lighting B.V., BG Light Sources & Electronics, P.O. Box 80020, NL-5600 JM, Eindhoven, The Netherlands

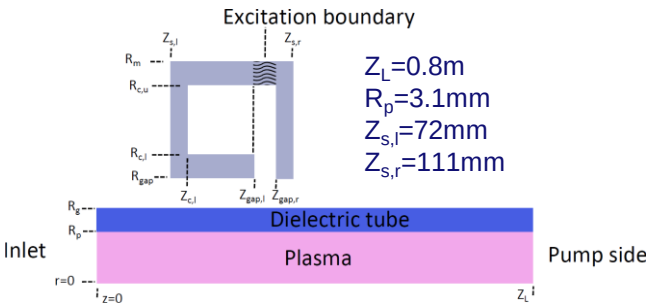
Contact: j.f.j.janssen@tue.nl

Introduction

Glass fibers can be produced via plasma enhanced chemical vapor deposition (PECVD). In such a process O_2 and $SiCl_4$ are fed to a microwave reactor. Due to the absorption of the microwaves various species are formed in the plasma. In simplified mixtures of Ar and Ar+$SiCl_4$ the effect of $SiCl_4$ on the discharge is investigated.



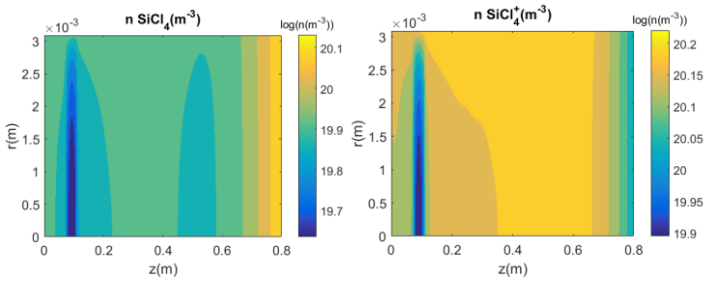
Surfatron



Z_L=0.8m
R_p=3.1mm
$Z_{s,l}$=72mm
$Z_{s,r}$=111mm

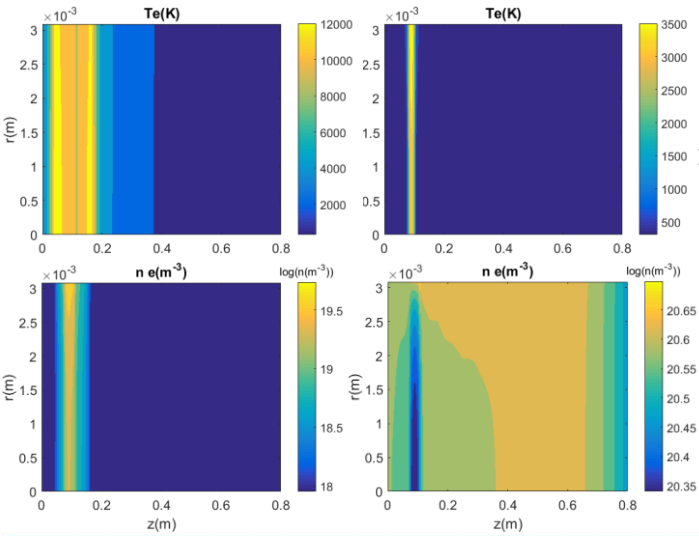
Densities of $SiCl_x$ species

The current set of chemical reactions produces $SiCl_x$ species that differ by about a factor 10. The species with the highest densities are $SiCl_2$ and $SiCl_4$. The ionic species reach values in the order of 10^{19}-10^{20}.



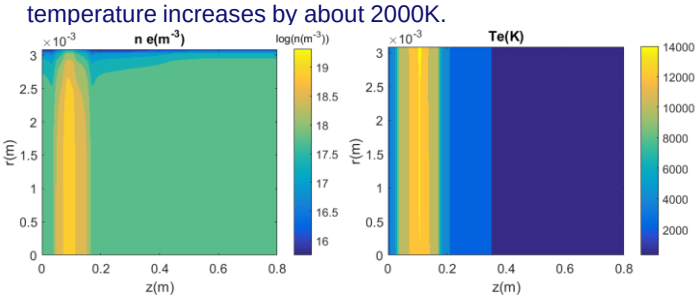
Ar vs Ar+$SiCl_4$

The discharge is simulated with an input power of 10W and an Ar flow rate of 215 sccm and a $SiCl_4$ flow of 0.5 sccm. The input power and the flow rate are reduced in comparison to experimental conditions.
Adding $SiCl_4$ to the discharge considerably decreases the electron temperature. The reason for this decrease is the increase of the electron density. The relatively small volume with a high electron temperature limits the energy transfer from the electrons to the heavy particles. Elastic energy transfer is the dominant loss term for the energy.



Wall reactions

The current model is unstable when wall reactions are included for $SiCl_x$ species. In a pure Ar plasma the effect of wall reactions is investigated. The electron density decreases considerably near the wall. The electron temperature increases by about 2000K.



Conclusion/Outlook

A first step towards modeling the Ar+$SiCl_4$ plasma is made. In the future it will be possible to model the experimental conditions when a self-consistent diffusion model is used instead of Fick's model. The model can further be improved by making the wall chemistry dependent on the deposited material.