Chemical kinetic modeling of Transient Spark discharge

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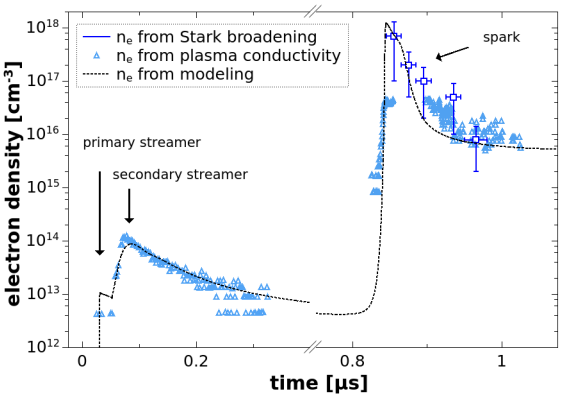

Fig. 1 Comparison of measured and calculated electron density during transient spark discharge current pulse.

1. Introduction

The chemical kinetic modeling of the density evolution of species included in the model is commonly used in plasma chemistry. The kinetic modeling could also help us to improve our understanding of the chemistry induced by the Transient Spark (TS) discharge [1].

The TS is a dc-operated self-pulsing (~1-10 kHz) discharge initiated by a streamer. Thanks to the short (~10-100 ns) high current (~1-20 A) spark pulses, the TS generates strongly ionized non-equilibrium plasma.

2. Model description

The model is based on the existing ZDPlasKin module [2] and set of reactions in N_2-O_2 mixtures provided by ZDPlasKin authors (version 1.03). The ZDplasKin package includes a Bolsig+ solver for the numerical solution of the Boltzmann equation. The electron scattering cross sections were taken from the LXCat project database [3]. The additional module compatible with ZDPlasKin was created, taking into account fast changes of conditions (reduced electric field strength, gas temperature, ...) during the evolution of TS discharge, starting from the primary streamer till the end of the spark phase.

3. Results and Conclusions

The comparison of calculated electron density (Fig. 1) with experimental data [4] indicates that created model is suitable for further study of the TS. The model uses Maxwellian electron energy distribution functions defined by the electron temperature T_e during the spark phase characterized by high degree of ionization. The evolution of T_e during the spark phase is calculated by energy balance equation. Further development of our model is needed to include the post-spark relaxation phase.

Acknowledgement: Supported by Slovak Research and Development Agency APVV-17-0382.

References

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[4] M. Janda et al. Plasma Sources Sci. Technol. **23**, 065016 (2014).