Electric field measurements in an atmospheric pressure radio frequency plasma using Stark polarization spectroscopy

Lei Wang*, Nikola Cvetanović‡, Bratislav Obradović‡, Gheorghe Dinescu§, Christophe Leys*, Anton Nikiforov*

*: Department of Applied Physics, Ghent University, Sint-Pietersnieuwstraat 41 B4, 9000 Gent, Belgium. Email: lei.wang@ugent.be
‡: Faculty of Physics, University of Belgrade, PO Box 368, 11001 Belgrade, Serbia
§: National Institute of Laser, Plasma and Radiation, Magurele-Bucharest, MG-36, Ilfov RO 077125, Romania

Abstract

Atmospheric pressure radio frequency(RF) plasma has been used not only in scientific research but also for industrial and medical applications, including surface cleaning, tooth root canal therapy, nanocomposite synthesis, etc. [1,2]. Though a lot of research has been performed on understanding this kind of plasma, the knowledge of its physics, especially RF electric field is still limited and in demand. Stark polarization spectroscopy is applied to investigate the electric field in an atmospheric pressure radio frequency helium plasma with a pin-sphere electrode geometry. Time resolved He I emission near electrode surface in an RF period is recorded and analyzed, as shown in figure 1 for grounded spherical electrode. Helium I lines at 492.19nm with allowed transition ($2p\ ^1P^o$–$4d\ ^1D^o$) and forbidden transition ($2p\ ^1P^o$–$4f\ ^1F^o$) are observed and used for electric field calculation. Polarized π components of He I transitions, which are parallel to electric field, are selected through a linear polarizer. The distance between polarized field free allowed line and forbidden line is related to electric field imposing on the radiative helium atoms. Analysis of the He I emission allows to estimate time resolved electric field distribution in the sheath and bulk of the discharge. The electric field at the peak voltage near the grounded electrode ranges from 3.7±0.4 kV/cm to 94±3 kV/cm. This study aims to contribute to the atmospheric pressure radio frequency helium plasma physics.

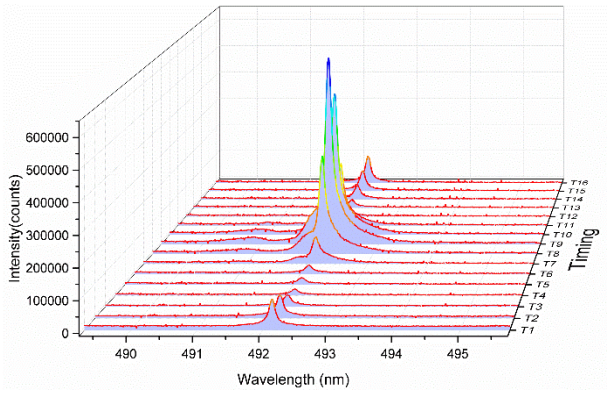

Fig. 1: Time resolved He I emission near spherical electrode

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