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Atmospheric pressure plasma in close proximity to liquid and its applications in synthesis of nanoparticles

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Atmospheric pressure plasmas have attracted a tremendous amount of interest from the plasma community because their numerous applications in diverse fields spanning materials science and nanotechnology on one hand, and biotechonology and medicine on the other [1].

In this talk, I will present our recent work on plasma density measurement and the effect of duty cycle on pulsed discharge atmospheric pressure plasma in close proximity to the liquid.

Since the inductance of the plasmas is a function of the plasma size and the electron density, an imaging method is developed to quantify the plasma size and the electron density. Comparing the electron density values calculated by the I-V, Stark broadening, and imaging methods, it can be seen that the electron densities calculated by the imaging and Stark broadening methods agree well with each other as shown in fig. 1[1].

We also study the excitation temperature and electron density at different duty cycles and find that a short duty cycle is beneficial to improve both the excitation temperature and electron density of the atmospheric pressure plasma. The numerical simulations are also performed to explain the experimental results, and the simulation results are further validated by the time resolved measurements of the electron density and excitation temperature. This work reveals that the remnant electron density left by the previous pulse determines the time-averaged electron temperature by affecting the initial peak amplitude of the electron temperature. The electron density at different duty cycle is coupled with the change of the discharge volume in the open air[2].

The above results will help us to get an atmospheric pressure plasma with controllable plasma density and temperature, to make the atmospheric pressure plasma more beneficial in engineering and synthesis of materials.

By applying atmospheric pressure plasma-assisted nanofabrication, we produce crystalline Ag Nps, well-mixed Au/Ag nanoalloy and carbon nanoparticles[3], the work shed light on the potential application of plasma-assisted nanofabrication performed at ambient conditions (i.e. room temperature and atmospheric pressure) as an effective, low cost, viable green alternative to nanoparticle synthesis.

References

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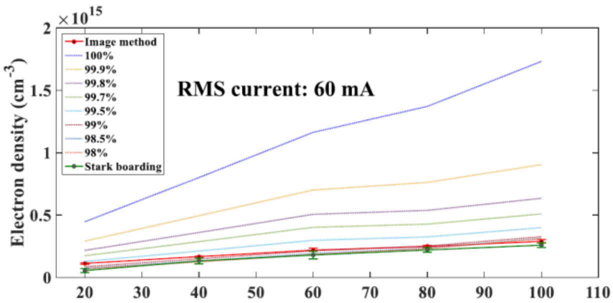

Fig. 1 Eelectron density versus the gas flow rates measured by three methods (Stark broadening, I-V and image method)[1].

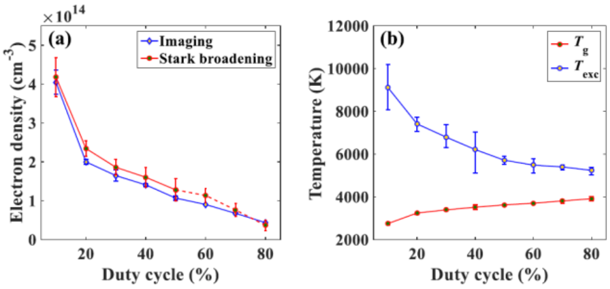

Fig. 2. Diagnosed results of the plasma parameters at different duty cycles. (a) Electron density. (b) Excitation temperature and gas temperature [2].