The influence of non-thermal Ar plasma jet on physicochemical properties of treated liquid

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We investigated an atmospheric pressure plasma jet (APPJ) that generates a streamer discharge above the liquid sample. In order to create plasma-activated water (PAW), the device was used for treating both distilled and tap water. The working gases were Ar and an admixture of Ar and synthetic air. Optical characterization of the plasma gas phase showed that the streamer discharge, in addition to the excited Ar lines, produces an abundance of reactive oxygen and nitrogen species (RONS) above and in the treated water. The measurement of the physicochemical properties of PAWs showed that different types and concentrations of the measured RONS (H_2O_2, NO_3^-, NO_2^-) were formed in different targets.

1 Introduction

The development of APPJs in recent years has been initiated by applications in various fields, among which are biomedicine [1-2] and plasma agriculture [3]. In these fields, plasma-treated liquids play an essential role [4]. In order to always provide the same treatment conditions, ensure the safety of the target and improve the properties of the treated liquid, a thorough study of these systems is necessary.

Here we will present the results of the influence of parameters such as feed gas, treatment time, sample properties and treated volume on the creation of reactive species in both the gas and liquid phase.

2 Experimental setup

In this work, we employed APPJ with pin electrode configuration that operated in kHz regime. As a working gas we used Ar and Ar+Air and plasma was generated above the liquid sample. Electrical characterization and discharge power measurement were conducted to acquire additional information about the treatments' stability, plasma properties and impact of plasma parameters on PAW. We have used spectrally resolved imaging and optical emission spectroscopy for determination and spatial distribution of excited species created in plasma-liquid interaction. We have treated distilled and tap water samples for different treatment times. After treatments, detailed liquid sample diagnostics including electrical conductivity, temperature, pH and RONS measurement were performed.

3 Results and conclusion

Figure 1 shows recorded optical emission spectra of Ar discharge (gas flow 1slm) from the gas gap between the powered electrode and water surface. The right hand side of Figure 1 represents the discharge structure captured by ICCD with addition of the optical filter (@310nm). A correlation between plasma and liquid properties has been established over a wide variety of plasma parameters and liquid targets. The obtained results demonstrated a link between the formation of RONS in the gas phase and in PAW.

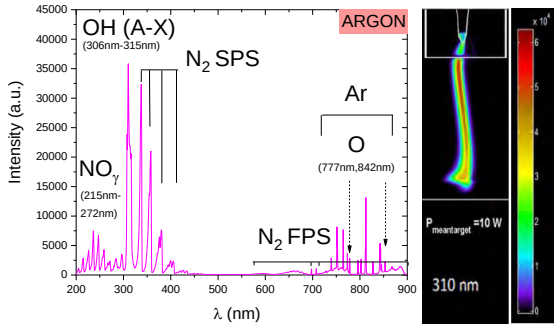

Fig. 1. The obtained optical spectra of Ar plasma above the water sample (left) and the ICCD image of discharge recorded by using 310nm optical filter (right).

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