

# Diagnostic Studies of Plasmas in Saline Solutions: the Frequency Effects and the Electrode Erosion Mechanism

Cheng-che Hsu

Dept. of Chemical Engineering, National Taiwan University

Plasmas in saline solutions receive considerable attention in recent years. How the operating parameters influence the plasma characteristics and how the electrode erosion occurs have been topics that require further study. In the first part of this talk, the effect of the frequency on the plasmas characteristics in saline solution driven by 50~1000 Hz AC power will be presented. Two distinct modes, namely bubble and jetting modes, are identified. The bubble mode occurs under low frequencies. In this mode, one mm-sized bubble is tightly attached to the electrode tip and oscillates with the applied voltage. With an increase in the frequency, it shows the jetting mode, in which many smaller bubbles are continuously formed and jetted away from the electrode surface. Multiple mechanisms that are potentially responsible to such a change in bubble dynamics have been proposed and the dominant mechanism is identified. From the Stark broadening of the hydrogen optical emission line, electron densities in both modes are estimated. It shows clearly that the driving frequency greatly influences the bubble dynamics, which in turn alters the plasma behavior.

In the second part, the study of the erosion of a tungsten electrode immersed in saline solution under conditions suitable for bio-medical applications is presented. The electrode is immersed in 0.1 M saline solution and is positively or negatively biased using a DC power source up to 600 V. It is identified that when the electrode is positively biased, erosion by the surface electrolytic oxidation is the dominant mechanism with an applied voltage below 150 V. An increase in the applied voltage leads to the formation of the plasma and the damage by the plasma and the thermal effect becomes more prominent. The formation of the gas film at the electrode surface leads to the formation of the plasma and hinders the electrolytic erosion. In the negatively-biased electrode, no electrolytic oxidation is seen and the damage is mostly likely due to the plasma erosion and the thermal effect.

**Keywords:** Plasma, Saline Solutions, Electrode Erosion