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Experimental Investigation of Pulsed High-Voltage Glow Discharge for Plasma Surface Modification

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Conventional plasma surface treatment processes such as plasma nitriding are generally conducted at a low voltage (less than 1000V) and high gas pressure (hundreds of mTorr). In contrast, conventional ion implantation is performed at a relatively high voltage (tens to hundreds of kV) and high vacuum (sub-mTorr). Pulsed high-voltage glow discharge has recently emerged as an alternative plasma surface modification method. The parameters of this technique lie between the two aforementioned techniques, thus permitting more flexible adjustment of the working gas pressure and treatment voltage. Consequently, the pulsed glow-discharge technique has potentially a wide range of applications. In this paper we experimentally investigate the discharge characteristics including the plasma gas ignition voltage and dynamic relationship of the voltage and current in pulsed mode. The experiments are conducted with the cathode in a cylindrical vacuum chamber 1200mm tall and 1000mm in diameter. We investigate the influence of the gas pressure, gas species (for example, hydrogen, nitrogen, argon), treatment voltage, and other factors on the glow discharge characteristics and use our results to predict the plasma sheath dimension based on the measured I-V curves. We will also discuss the effects of free electrons emitted by the hot filaments on the high voltage glow discharge process.

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