

Comparison among Plasma Parameters and DC Laser Photodetachment Signals of a Carbon Thermionic Cathode Discharge

正木 伸吾¹, 橋口 泰昌¹, M.R. Vasquez Jr.², 和田 元¹
 Shingo Masaki¹, Yasumasa Hashiguchi¹, M.R. Vasquez Jr.² and Motoi Wada¹

¹同志社大学大学院理工学研究科

¹Graduate School of Science and Engineering, Doshisha University

² Department of Mining, Metallurgical, and Mining Engineering, College of Engineering, University of the Philippines

1. Introduction

Carbon thin films such as diamond-like carbon can be utilized in various fields for their unique characteristics and functions. One way to form such films is to use carbon containing plasma, in which the fundamental behavior of negative ions can affect the quality of the formed film. In this experiment, we measure the photodetachment signals proportional to negative ion density in a carbon thermionic cathode discharge to investigate correlation among plasma parameters and the photodetachment signals.

2. Experimental setup

Fig. 1 shows the schematic diagram of the ion source. A cylindrical ion source made of stainless steel has an inner diameter of 150 mm and a length of 200 mm. The carbon cathode filament has a width of 4.0 mm, a length of 85 mm and a thickness of 0.2 mm. A high temperature carbon filament emits thermal electrons to produce a carbon containing plasma in Ar filling gas. The photodetachment electron current induced by a 808 nm wavelength diode laser, is detected with a Langmuir probe. A schematic diagram of the electrical circuit to measure the photodetachment signal is shown in Fig. 2.

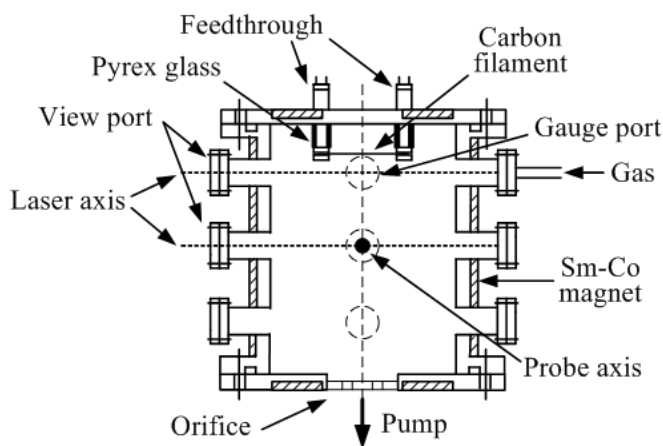


Fig. 1. A schematic diagram of the ion source.

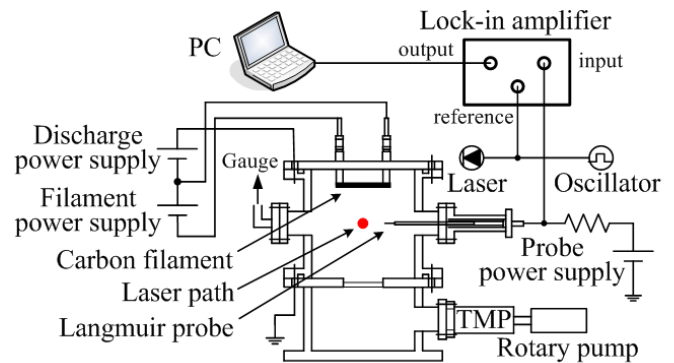


Fig. 2. A schematic diagram showing the electrical circuit to measure photodetachment signal.

3. Discharge characteristic

Fig. 3 shows the characteristics of discharge current against filament current. The experiments were operated with both conditions at 5.0×10^{-1} Pa Ar gas pressure and no introduction of Ar gas. A negative 40 V bias was applied to the cathode to the ion source chamber while 23.4 A of filament current was induced with no gas charging. Gas pressure increased to 8.0×10^{-4} Pa with 3 mA discharge current from 2.5×10^{-4} Pa base pressure. One possible explanation for this discharge may be collision of thermal electrons with gas phase carbon sublimated from the hot carbon filament.

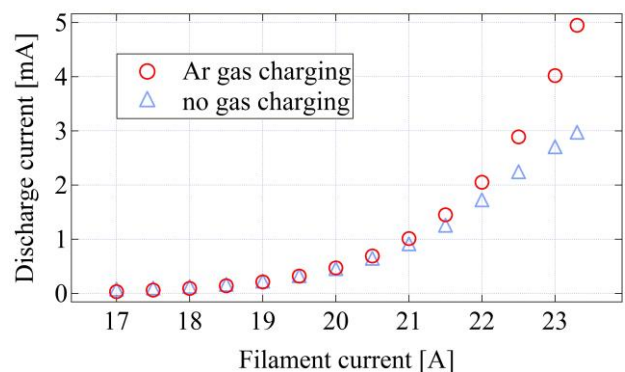


Fig. 3. The characteristics of discharge current with filament current.