Research on photoelectric current measuring circuit for analyzing the energy characteristics of 157nm excimer laser

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Received 16 February 2004; accepted 11 January 2005

Abstract. A simple and effective photoelectric current measuring circuit is introduced, which is used to analyze the energy characteristics of the 157 nm excimer laser. Comparisons are carried out for different grounding position, different distance between the electrodes and measuring apparatus. In addition, the circuit is used to detect the energy characteristics of the 157 nm excimer laser. The experimental results are useful for the actual photoelectric effect measuring work.

Key words: energy measurement, excimer laser, photoelectric current

1. Introduction

Most of the materials have lower photoelectric work function (<5 eV) than the deep-ultraviolet 157 nm photon energy (7.9 eV), so it provides an extensive field in laser material processing especially in the condition of vacuum ultra-violet (VUV) for the 157 nm excimer laser (Lambda Physik 1999; Herman 2001; Gu 2002). Some technologies about the single-photon photoelectric effect caused by the ultraviolet (UV) laser photons are under investigation and development (Papadogiannis 2001). Different with the previous work, a feasible method is proposed here to measure the laser energy characteristics of the 157 nm excimer laser, and the emphasis is focused on the comparisons of the measuring circuits in several aspects. The experimental results show some practical significance for the photoelectric effect measuring work and the study of the energy characteristics of the F2 laser.

2. Photoelectric current circuit setup

Based on the photoelectric effect theory (Serway 2003), the photoelectric current caused by the 157 nm laser can be measured through the simple circuit as shown in Fig. 1.
The excimer laser, OPTEX F2 (LAMBDA PHYSIK), is designed for 0 ~ 200 Hz repetition rate and the laser energy can be adjusted among the range of the laser high discharge voltage (HV%:0 ~ 100%). The cathode material is Au (4.82 eV) (CRC 1974). The laser outlet is well sealed with the vacuum chamber. When the laser is illuminating the cathode, the electrons will absorb the photons energy and escape from the cathode surface. And because of the electric potential difference between the electrodes, the electrons will be captured by the anode and thus produces photoelectric current, which can be detected by the high accuracy ampere-meter.

The relation between the laser energy $E_L$ and the measured photoelectric current $I$ is:

$$I = \frac{E_L}{E_p} \times f \times \eta \times e$$

where $I$ is photoelectric current, $E_L$-laser energy per pulse, $E_p$-photon energy, $f$-pulse repetition, $\eta$-quantum efficiency, and $e$-electron quantity.

3. Comparisons for different measuring circuits

Three different measuring circuits setup are given in Fig. 2(A) for comparing different circuit grounding position. Figure 2(B) shows the experimental