Development of a photocathode-type pulsed electron gun for time-resolved electron diffraction measurements

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Geometrical structures of polyatomic molecules in the gas phase and its temporal evolution can be probed by time-resolved gas-phase electron diffraction with high temporal resolution of the order of picoseconds and high spatial resolution (~0.01 Å) [1]. In order to achieve much higher temporal resolution, our group showed that laser-assisted electron diffraction (LAED) [2] is a promising method and that LAED patterns of CCl_4 molecules can be recorded using a 1 keV electron beam [3].

In the present study, in order to achieve the higher acceleration voltage for an electron beam so that the spatial resolution of the LAED measurements becomes higher, we upgraded an electron gun. In order to prevent the discharge within a home-built electron gun at the negative high voltage below −5 kV, we renewed the covering insulator of the wire supplying a high voltage to a photocathode and polished the surfaces of the grounded anode and the photocathode holder with metal polish. With the above improvements, it was confirmed that no electrostatic discharge occurred for three days at the high voltage of −7 kV.

The performance of the high-voltage electron gun has been demonstrated by the measurements of a diffraction pattern of graphene, showing that the electron diffraction at the acceleration voltage as high as 5 kV can be recorded using the experimental setup equipped with the upgraded electron gun. The next step is to record laser-assisted electron diffraction of molecules at the high acceleration voltage for probing ultrafast changes of the geometrical structure with high spatial resolution.

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