18-3

Manufacturing and Characteristics of A New High-intensity Ultra Violet Light Generator

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The Ultraviolet Photoelectron Spectroscopy (UPS) technique is extermely sensitive to molecular orbitals on surface and the valence electron density. As it is the line source originated from discharge of the rare gas, the resolution of the specroscopy is not limited by the source but is limited by the analyzer. Therefore the most efforts to build the excellent source are devoted to induce the high intensity of light for further applications such as angle-resolved UPS and polarization of the incident beam. The discharge region, however, can not be separated from the main chamber due to absorption of UV light to window, there is the problem of differential pumping in UPS. The cathode is always sputtered during operation and has the limited life-time.

In order to solve the problems in the commercial UV generator, we have built a new generator which is compact, easy to replace parts, non-welded, air-cooled, well beam-guided, well discharge-confined and high-intensity generating. It is the cold cathode discharge type generator[1]. The main body is made of stainless-steel except the cathode and anode made of aluminum and the discharge quartz-cylinder. The rare gas passes through the 10mm diameter discharge cylinder without leaking and all the inserted gas consumed for productive beam. The beam guiding and differential pumping sections are separated from the discharge section that the degraded cathode can be replaced without disturbing those sections. As the cathode is bolted to the main body, the main body is just air-cooled by the external fan. Actual discharge is found to exist in the 4mm-diameter and 6cm-long cylinder which is extended from the middle of quartz tube to the beginning of the beam-guiding and one-piece pyrex tube with 1-2mm diameters. Each differential pumping sections are separated by press-fit aluminum adapter and viton-O ring.

The photo-current monitored from the Ta plate located at the end of the beam-guiding pyrex tube by the picoanmeter. It has been found from Ne-discharging that for the same discharge power the photo-current shows the maximum at the certain gas pressure which is assumed to be the optimum pressure for discharging. For He-discharge, the same trend was shown. For Ne-discharge, with 260V and 200mA discharge power, the photocurrent was 150nA. For He-discharge, with 230V and 200mA discharge power, the photocurrent was 105nA. From the surface with condensed water, with analyzer resolution 220meV, i.e.,

FAT 10 and 230V-100mA discharge power the O lone-pair orbital peak height was 2700 counts/sec from He I and 180 counts/sec from He II. One of the typical spectra from condensed water is shown in Fig.1.

[1] J. A. R. Samson, "Techniques of Vacuum Ultraviolet Spectroscopy", in Wiley Series in Pure and Applied Spectroscopy, John Wiley & Sons, Inc, 1967.

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Fig.1. UPS spectrum obtained from H_2O condensed Si(111) wafer. In order to make sure the spectrum from the sample, -5V bias was applied. The intensity ratio of O lone pair orbitals due to He I (21.2eV) and He II (40.8eV) was 1:15.