

Photoemission Electron Micro-spectroscopic Study of the Conductive Layer of a CVD Diamond (001)2x1 Surface

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The surface conductive layer (SCL) of chemical vapor deposition (CVD) diamonds has attracting much interest. However, neither photoemission electron microscopic (PEEM) nor micro-spectroscopic (PEEMS) information is available so far. Since SCL retains in an ultra-high vacuum (UHV) condition, PEEM or PEEMS study will give an insight of SCL, which is the subject of the present study. The sample was made on a Ib-type HTHP diamond (001) substrate by non-doping CVD growth in a DC-plasma deposition chamber. The SCL properties of the sample in air were; a few tens K/Sq. in sheet resistance, $\sim 180 \text{ cm}^2/\text{vs}$ in Hall mobility, $\sim 2 \times 10^{12}/\text{cm}^2$ in carrier concentration. The root-square-mean surface roughness (R_q) of the sample was $\sim 0.2 \text{ nm}$ as checked by AFM. A 2x1 LEED pattern and a sheet resistance of several hundreds K/Sq. in UHV were checked in a UHV chamber with an *in-situ* resist-meter [1]. The sample was then installed in a commercial PEEM/S apparatus (Omicron FOCUS IS-PEEM) which was composed of electro-static-lens optics together with an electron energy-analyzer. The presence of SCL was regularly monitored by measuring resistance between two electrodes (colloidal graphite) pasted on the two ends of sample surface.

Figure 1 shows two PEEM images of a same area of the sample; a) is excited with a Hg-lamp and b) with a Xe-lamp. The maximum photon energy of the Hg-lamp is $\sim 4.9 \text{ eV}$ which is smaller than the band gap energy ($E_G = 5.5 \text{ eV}$) of diamond and the maximum photon energy of the Xe-lamp is $\sim 6.2 \text{ eV}$ which is larger than E_G . The image that appear with the Hg-lamp can be due to photo-excitation to unoccupied states of the hydrogen-terminated negative electron affinity (NEA) diamond surface [2]. Secondary electron energy distribution of the white background of Figs.1a) and b) indeed shows that the whole surface is NEA except a large black dot on the upper center.

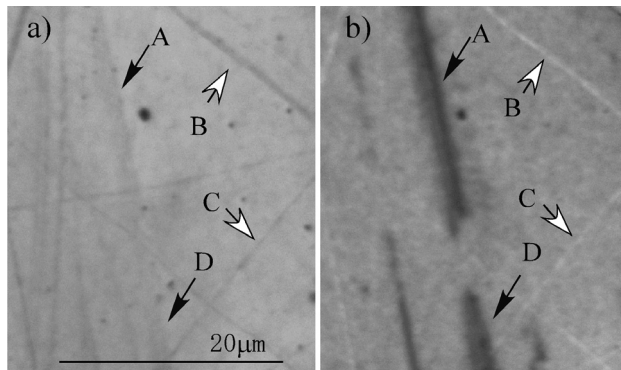


Fig. 1. PEEM images of a CVD diamond (001) 2x1 with surface conductive layer. a) with Hg-lamp excitation, b) with Xe-lamp excitation.

However, Figs.1a) and 1b) show several features that are qualitatively different from each other. Some of the differences are the followings: the two main dark lines A and B in Fig.1b) are not at all obvious and the white lines B and C in Fig.1b) appear to be dark lines in Fig.1a). A PEEMS analysis of secondary electron energy distribution showed that all of the features A-D have negative electron affinity with marginal differences among them. These differences can be attributed to differences in the details

of energy band bending underneath the surface present in SCL [3].

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