PEEM observation of desorption process of pentacene on graphite

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Pentacene (Pn) has recently received interest due to a relatively high hole mobility in organic field effect transistors (OFETs). Performance of OFETs is affected by charge mobility in organic thin films. The mobility is limited by grain boundaries in the films and molecular orientation/packing in each domain. Therefore, it is important to investigate structure of organic films. In addition, a "good" molecular monolayer has been required for discussing electronic properties of organic/inorganic interface [1]. Hence, a method to form the monolayer has been desired. In this study, we investigated structure of pentacene thin films and effects of heat treatment by PEEM.

Pn thin films were evaporated onto clean highly oriented pyrolytic graphite (HOPG) substrates. In the PEEM measurements, D_2 lamp was used to excite photoelectrons ($h\nu<6.8$eV).

Fig.1 shows PEEM images of Pn (15Å)/ HOPG at same area. Fig.1a represents the PEEM image at substrate temperature (T_s) of 300K. In the image, bright areas correspond to Pn areas, because the number of photoelectrons from Pn areas is lager than those from HOPG substrate [2]. Furthermore a linear boundary between bright and dark area can be seen. The boundary corresponds to a step structure of the substrate (indicated by arrows in Fig.1). In addition, small Pn islands distribute along the step (can not seen in these images), indicating that molecules aggregate at defects of the substrate surface. Figs.1b represents PEEM image at higher Ts (350K). From the comparison of Fig.1a and b, it is found that Pn areas become smaller, indicating Pn molecules can desorb even at 350K. Fig.1c shows the PEEM image at 300K after heating at 375K for 2h, which was recorded with longer exposure time (1min.) than those for other images (10sec.). From UPS study of Pn/HOPG system, there are "standing" Pn molecules and flat-lie orientation coexists in as-grown ultrathin films. Ionization energy of "standing" Pn molecules is smaller (4.7eV) than that of the flat-lie orientation (5.5eV). In addition, a flat-lie Pn monolayer can be prepared by heating the films at around 380K [2]. Hence bright areas in Fig.1a correspond to "standing" Pn areas and Fig.1c represents uniform Pn monolayer of flat-lie orientation. The present study indicates that islands/grains of standing/tilting molecules grown at defects of HOPG surface are selectively removed by heat treatment at around 375K, and a uniform monolayer of flat-lie molecular orientation can be obtained on the HOPG surface.

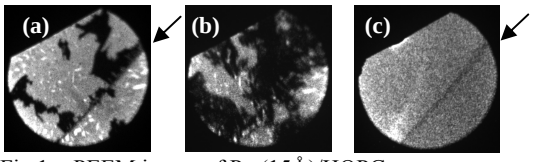

Fig.1 PEEM image of Pn (15Å)/HOPG
Ts = (a) 300K, (b) 350K, (FOV=44μm)
(c) 300K (after heating at 375K for 2h.)

[1] H. Yamane et al, . Phys. Rev. B**72** (2005) 153412 [2] H. Yamane et al, . IPAP conf. series **6** (2005) 19