ST-P006

Influence of Dangling Bonds on Nanotribological Properties of Alpha-beam Irradiated Graphene

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We have investigated the influences of dangling bonds generated by alpha particle irradiation on friction and adhesion properties of graphene. Single layer of graphene grown with chemical vapor deposition on copper foil was irradiated by the alpha beam with the average energy of 3.04 MeV and the irradiation dosing between 1×10^{14} and $1\times10^{15}/cm^3$. Raman spectroscopic showed that the π electron states below Fermi level arises and the I_D/I_G increases as increasing the dosing of alpha particle irradiation. The core level X-ray photoelectron (XPS) revealed that these defects represent the creation of various carbon-related defects and dangling bond. The nanoscale tribological properties were investigated with atomic force microscopy in ultrahigh vacuum. The friction appeared to increase remarkably as increasing the amount of dosing, indicating that the dangling bonds on graphene layers enhances the energy dissipations in friction. This trend can be explained by the additional channel of energy dissipation by dangling bond or O- and H- terminated clusters created by alpha particle irradiation.

Keywords: Alpha-beam, Graphene, Atomic force microscopy, Friction, Adhesion