

Surface science studies at the SINS beamline

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Introduction:

Synchrotron radiation based techniques, such as X-ray photoemission spectroscopy (XPS) and X-ray absorption spectroscopy (XAS), are powerful tools for studying novel materials from thin films to nanostructures with surface sensitivity. These techniques can offer unique electronic, magnetic, chemical, and even some structural information.

The SINS beamline at Singapore Synchrotron Light Source (SSLS), which was recently installed and tested, provides a photon energy range from 50 to 1200 eV with typical resolution ($E/\Delta E$) and flux of about 10^9 at 10^{11} photons/s. This unique tunable light source is ideal for the photoemission (XPS/UPS) and XAS to study the surface, interface, and nanostructure science.

SINS end-station



Omicron Multiprobe vacuum system with fast entry

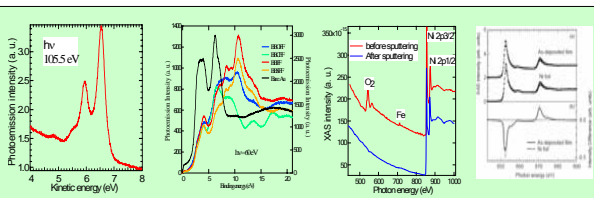
EA 125 hemispherical energy analyzer
 Twin anode (Mg, Al) standard x-ray tube

LEED system, ion sputter source, and e-flux electron beam evaporators, magnetic coil

STM/AFM chamber

Preparation chamber

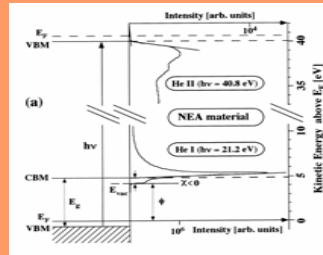
Synchrotron-based surface analysis available at SINS endstation



XPS **UPS** **XAS/XANES** **XMCD**

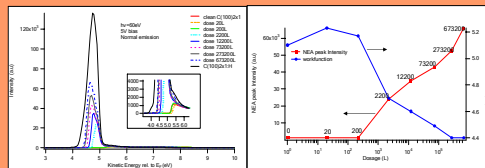
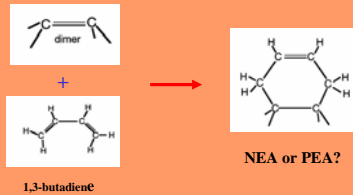
XPS/UPS – elemental, chemical information/electronic structure; XAS/XANES - elemental, chemical information; XMCD – elemental magnetic information.

Negative Electron Affinity of Diamond (100) surface induced by Diels-Alder Reaction



negative electron affinity (NEA) means the conduction band minimum (CBM) of certain material lies above the vacuum level. So the electrons excited into the conduction band can be thermalized to the CBM and emitted into vacuum without any energy barrier

Clean C(100)2x1 (PEA)



UPS (low kinetic energy part) at various dosages

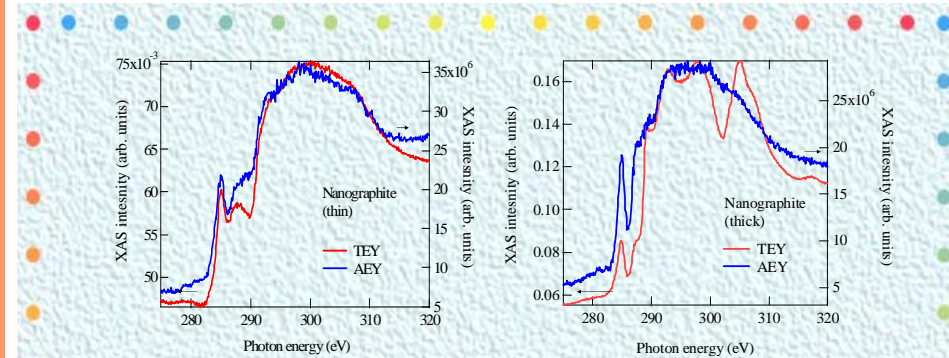
NEA peak and work function as function of Dosage

Surface remained PEA below 220L dosage and then changed to NEA with the NEA peak intensity increasing logarithmically with 1,3-butadiene coverage. The lowering of vacuum level indicates that the work function was also decreased accordingly.

1,3 butadiene can readily chemisorb on clean diamond (100)2x1 through Diels-Alder reaction. Diels-Alder reaction induced NEA upon certain dosage of 1,3 butadiene

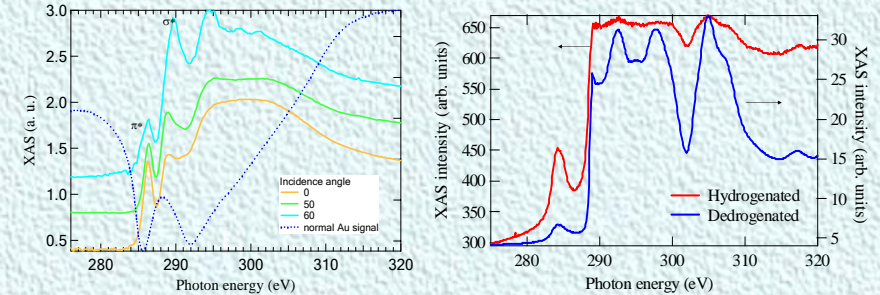
A possible combination of NEA effect with organic functionalization of diamond surfaces

C K-edge XANES of various samples



C K-edge XANES spectra of one kind of nanographite at different thicknesses

TEY (total electron yield) is less surface sensitive than AEY (Auger electron yield) for XANES. At lower coverage, nanographite are graphite-like. At higher coverage, the surface is still graphite-like, but the bulk tends to be diamond-like.

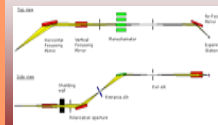


XANES spectra of one kind of polymer at different angles

XANES spectra of hydrogenated and bare diamond

The change of peak height of different peaks at different angles reveal the alignment of the polymer.

The saturation effects of XANES in TEY mode for hydrogenated diamond indicate long diffusion length of electrons.



Collaborations are welcome!

