초청강연8

Formation of two-dimensionally ordered atomic/molecular layers as new functionality materials

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Novel functional phases are expected to be prepared by arranging atoms and molecules on solid substrate in an ordered manner. Atomic and molecular layer epitaxy methods in vacuum are often used for this purpose. Although these techniques are very effective, the equipments are rather expensive and not many laboratories can afford the equipments.

Here, I show that highly ordered atomic (metal) and molecular layers can be grown on the single crystalline metal surfaces in solution. Two examples are presented.

One is the electrochemical atomic layer epitaxy of Pd on Au(111) and Au(100). We have monitored electrochemical deposition of Pd on Au single crystal electrodes by in situ STM and found that the deposition proceeds in layer-by-layer growth mode. XRD measurements showed that Pd(111) and Pd(100) phases are formed on Au(111) and Au(100), respectively, and the atom-atom distance of the first Pd layer is not of the Pd bulk but of the underlying gold according to the surface x-ray scattering (SXS) study. The electrochemical and catalytic behaviors of the first layer are significantly different from those of the corresponding phase of bulk crystals.

The other example is the self-assembly of alkylthiol molecules on Au(111). By just dipping the gold substrate in a dilute solution of the thiol, well ordered molecular monolayer (self-assembled monolayer:SAM) is formed. The self-assembly process was monitored by In situ STM. Surface functionality can be controlled by choosing the terminal group of the thiol. Novel functionalities we have achieved by this technique include highly efficient photoinduced electron transfer and second harmonic generation.

I will stress the importance of the order of the layers for obtaining highly controlled functions.