The Development of an Ultra-High Vacuum Optical Second Harmonic Microscope

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[Summary]

The purpose of this study is to develop an optical second harmonic microscope (SH microscope) with a resolution on the order of mm, and to observe the distribution of symmetry and electronic states on surfaces and interfaces during important surface and interface phenomena. Second harmonic generation (SHG) is a phenomenon in which harmonic light at frequency 2ω is generated into reflection direction from surfaces and interfaces by the second order nonlinear effect, when intense pumping light, such as laser light, at frequency w impinges on them.
With the SH microscope developed in this study, I can observe microscopic images of electronic states at surfaces even in an electrolytic solution or reaction gases, as long as probe light is able to reach the sample in such environment. Several studies on SH microscopy have been reported so far, however, no study has yet been reported on the observing of sample in ultra-high vacuum, electrolytic solution, and reaction gases.
The characteristics of the developed system are as follows.

- The spatial resolution of this system is about 6 mm and the field of view is 920×690 mm^2.
- The system has a capability of spectroscopic observation by using a tunable pumping light source.

In this study, microscopic SH images of CO and O coadsorption on a Pt(110) surface in ultra-high vacuum and those of pyridine adsorption on a roughened Ag surface in electrolytic solution have been obtained. In the case of CO and O coadsorption on the Pt(110) surface, a non-uniform density distribution of CO adsorption on the Pt(110) surface was observed. In the case of pyridine adsorbed Ag surface, the increase of the scattered SH intensity was observed from the boundary between an optical flat region and an electrochemically roughened region on the Ag surface upon pyridine adsorption. This result may show that there is a region where chemical enhancement of SH intensity is especially large. These types of information can never be obtained with the 1 point surface analysis by SHG method. Thus I conclude that the advantage of observing the distribution of SH intensity has been demonstrated in observing such surface phenomena with this developed SH microscope.

[Keywords]

optical second harmonic microscope (SH microscope), Pt(110), CO, Ag, pyridine