Plasmon-mediated multiple excitations observed in STM-induced light emission from rubrene/Au(111) thin films

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We studied scanning tunneling microscopy (STM)-induced light emission (STM-LE) spectra from rubrene/Au(111) thin films. In the cases of organic molecules on metallic substrates, STM-induced light emissions from both molecules and local surface plasmons (LSPs) are observed. In this paper, we introduce an intriguing result of STM-LE from rubrene/Au(111) that suggests plasmon-mediated multiple excitation with a new mechanism.

We performed STM measurements in both air and ultra-high vacuum (UHV) with constant-current mode. Emitted photons from tunnel junction were focused onto an entrance edge of an optical fiber using lenses and introduced to a monochromator. A high-sensitive CCD was used for detection. We used a newly developed wavelength-resolved 2D photon mapping system, for UHV-STM measurement, which consists of a photon detection system synchronized with STM. Signal intensity can be integrated for the specific regions as we like for a deeper analysis. Rubrene/Au(111) samples were prepared by vacuum deposition.

Figure 1 shows an example of STM-LE spectra from rubrene/Au(111) measured in air at room temperature. The film thickness was 15 nm. The energy corresponds to the bias voltage is indicated by the gray dashed line. Despite the lower bias voltage (1.8 V) than the molecular energy gap (2.1 V) identified by photoluminescence for an as-received rubrene powder at room temperature in air, the optical emission originated from rubrene molecules is observed as shown by an arrow in the figure. The threshold bias voltage was about 1.2 V. In consideration with the other experimental results obtained in air and vacuum, a plasmon-mediated multiple excitation process including a new mechanism was suggested for the case of rubrene/Au(111) thin film.

Details will be discussed at the symposium.

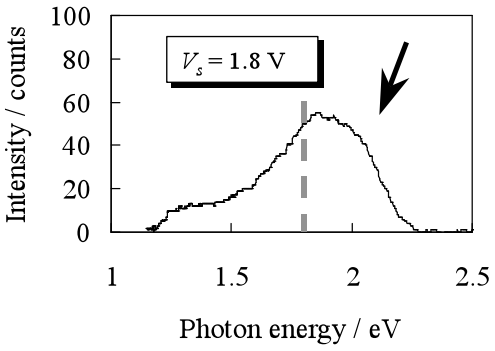

Fig. 1. An example of STM-induced light emission spectra from rubrene/Au(111) thin films (V_s: 1.8 V, I_t: 5.0 nA, scan area: 2 μm x 2 μm).