Plasmon-mediated light emission from metallophthalocyanine/Au(111) induced by STM

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SUMMARY:

We studied scanning tunneling microscope (STM)-induced light emission (STML) from metallophthalo- cyanine molecular films on Au(111). Bias-voltage and tunnel-current dependence studies revealed the existence of some characteristic mechanisms for the Plasmon-mediated emission processes of these systems.

INTRODUCTION:

For an organic molecular film adsorbed on a metal surface, STML with the molecular HOMO-LUMO gap energy can be sometimes obtained, even if the applied sample bias voltage is lower than the energy gap. A triplet-triplet annihilation (TTA) process was proposed based on the experiment for CuPc[1]. However in order to confirm such multi-electrons excitation, analyzing tunneling current dependence is also absolutely imperative.

EXPERIMENTALS:

STM measurements were performed in dry N_2 with constant-current mode. Metallophthalocyanine (CuPc and ZnPc) /Au(111) samples were prepared by vacuum deposition. Samples were handled in a darkroom to prevent degradation and desorption of the molecules prior to measurements.

RESULTS and DISCUSSION:

Fig. 1 shows sample-bias dependence of light intensity from the molecular films. The light emissions for both samples started from about +1.1 V, which correspond to the energies between their HOMO and triplet energy levels. And both curves sharply changed their slopes at the sample bias voltages around their HOMO-LUMO gap energies. In contrast, their tunneling-current dependences were completely different from each other as shown in fig. 2. That is, the relationship obtained for CuPc's and ZnPc's had parabolic and linear shapes, which correspond to two-electron excitation and one-electron excitation mechanisms, respectively.

CONCLUSIONS:

Our results indicate that the triplet-mediated-two-electron excitation model is acceptable to explain the process for CuPc molecular light emission. In contrast, for a ZnPc molecule, the sample-bias-voltage dependence of light intensity was similar to that for CuPc molecule, however, the tunneling current dependence showed a linear relationship, suggesting some other mechanism for the excitation of this case. Details will be discussed at the symposium.

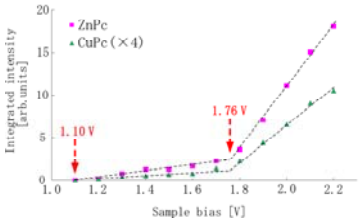

Fig. 1. Sample-bias dependence of light intensity from the molecular films (CuPc and ZnPc).

REFERENCES:

[1] T. Uemura et al., Chem. Phys. Lett. **448**. (2007) 232-236

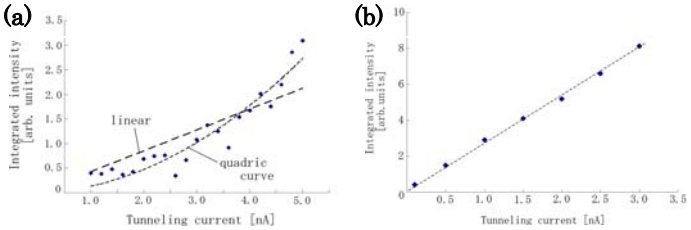

Fig. 2. Tunneling-current dependence of light intensity from the molecular films of (a) CuPc (b) ZnPc.