

Effect of various tunneling conditions on the dynamic motion of enclosed trimethylphosphine adsorbates

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Introduction

Dynamic motion of confined trimethylphosphine (TMP) molecules in pyrrole molecular fences can be used as a molecular switch or memory device if the motion of the TMPs can be controlled [1]. Manipulating the dynamic motion of TMP has been attempted by changing bias (V_s) and tunneling current (I_t) conditions of STM measurements.

Experimental

The STM measurements were carried out under UHV (1×10^{-8} Pa) conditions and at RT. Cleaned Si (111)-(7×7) surface was directly exposed to 1.5 L of purified pyrrole and then 0.5 L of TMP. Finally, the dynamic motion of TMP was observed using STM under different tunneling conditions.

Results and discussion

Bright spots marked with white arrows in the first STM image of Fig 1.(a) show the TMP molecules confined in pyrrole molecular fence, marked with red arrow. TMP movement would enhance if the positive sample bias were decreased. The relationship between the TMP movement and the positive sample bias is shown in Fig 1.(b). Also, we observed that changing tunneling current would not affect the movement of TMP molecules significantly. Tunneling current dependency experiment was carried out at three bias conditions and shown in Fig 1.(c). Therefore, we can suggest that TMP movement may be affected due to the shallow electronic states present in TMP adsorbates. At lower bias conditions, Si-TMP antibonding orbital gets stimulated efficiently by incoming tunneling electrons from the tip, weakening the bond and forcing TMP molecules to move more frequently.

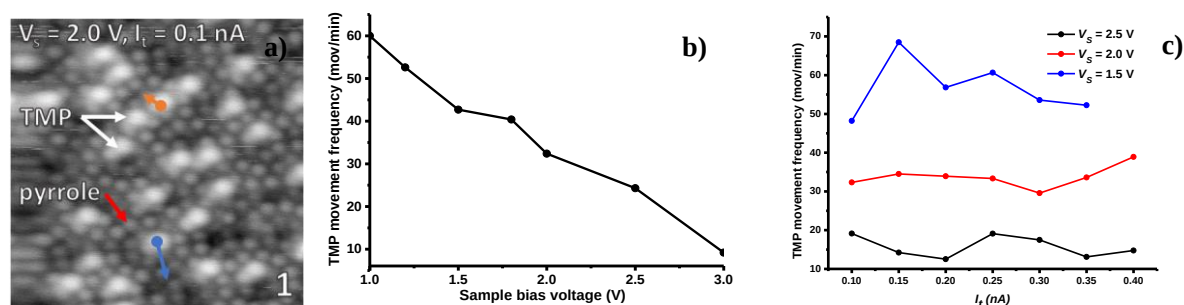


Fig 1. a) STM image showing TMP movement in pyrrole molecular fences, TMP movement dependency b) at different sample bias and c) at different tunneling current conditions.

Conclusion

The movement of TMP molecules inside the pyrrole molecular fence can be manipulated by changing the sample bias. Tunneling current does not have a significant effect regarding this.

References

- 1) M. Shimomura, A. Iwanabe, and T. Kiyose, J. Phys. Chem. C 118, 27465 (2014)