Wiring single metal-phthalocyanine molecules with conjugeted polymers

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In order to realize future nanophotonic or nanoelectronic devices, the use of single functional molecules as light emitters or electronic switches will be a good candidate. For making electric connections to individual functional molecules, a method to wire single molecules with conjugated organic polymers is required. We have developed a method using a probe tip of scanning tunneling microscope (STM) to control the chain polymerization of diacetylene compounds on a self-ordered layers, thereby creating single nanowires of conjugated polydiacetylene[1,2]. In this study, we will show nanostructures of metal-phthalocyanine (Me-Pc) molecules on a layer of diacetylene compound, and demonstrate the chain polymerization of diacetylene toward Me-Pc molecules.

10,12-Nonacosadiynoic acid [$CH_3(CH_2)_{15}C{\equiv}CC{\equiv}C(CH_2)_8COOH$] was used as a diacetylene compound, and Me-Pc was deposited on a layer of diacetylene on a graphite substrate. STM experiments were performed in air at room temperature.

STM images showed that the deposited Me-Pc molecules adsorbed especially along the boundary of the diacetylene domains (Fig. 1). Figure 1 also shows that stable nano-clusters, which are consisted of single to few Me-Pc molecules, are adsorbed on the diacetylene domains. Especially, nano-clusters consisted of five Me-Pc molecules (pentamer) were frequently observed as shown in Fig. 2.

The chain polymerization toward a pentamer was demonstrated in Fig. 3. The chain reaction was initiated by a pulsed bias voltage applied on the diacetylene molecular row indicated by the arrow. As a result, the chain polymerization of diacetylene was propagated toward the pentamer, and terminated at the site of Me-Pc. Similarly, we have succeeded in wiring a single Me-Pc molecule with two polydiacetylene nanowires.

1 Y. Okawa and M. Aono, Nature **409**, 683 (2001).
2 Y. Okawa and M. Aono, J. Chem. Phys. **115**, 2317 (2001).

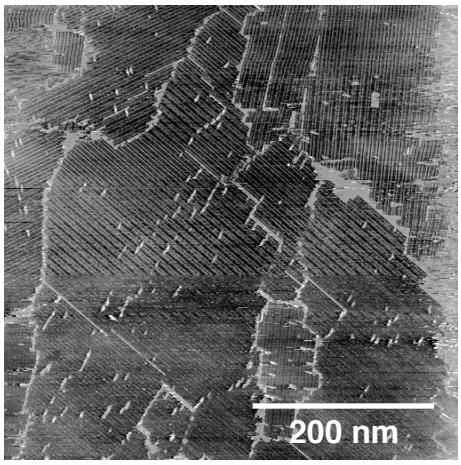


Fig 1: STM image of 10,12-nonacosadiynoic acid layer on graphite substrate, on which about 0.1 ML of copper phthalocyanine (Cu-Pc) molecules are deposited.

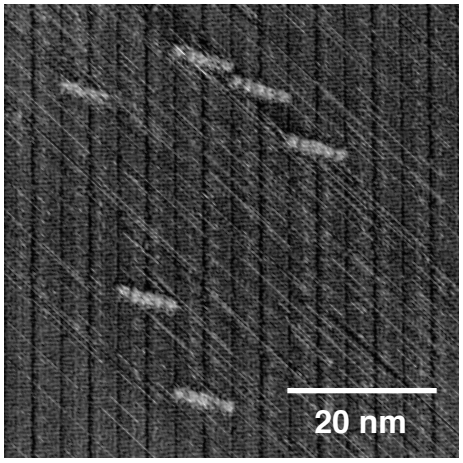
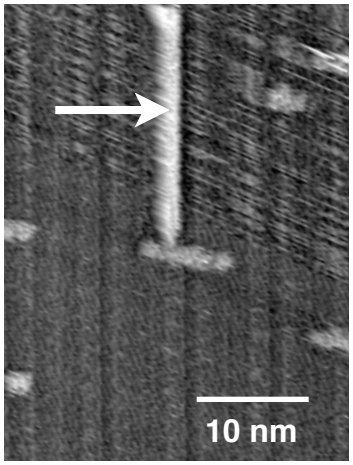


Fig 2: STM image of Cu-Pc pentamers on diacetylene layer.



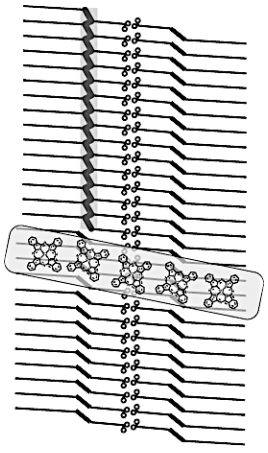


Fig 3: STM image showing the chain polymerization of diacetylene toward a Cu-Pc pentamer. A pulsed bias voltage was applied between the STM tip and the substrate on the diacetylene molecular row indicated by the arrow.