

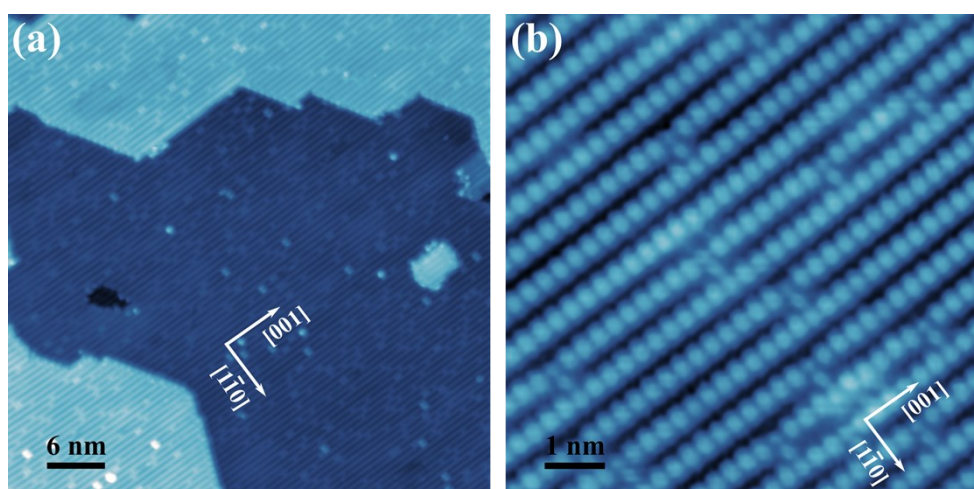
## Supporting information

### Adsorption of Acetylene on Rutile $\text{TiO}_2(110)$ Surface: A Low Temperature STM Study

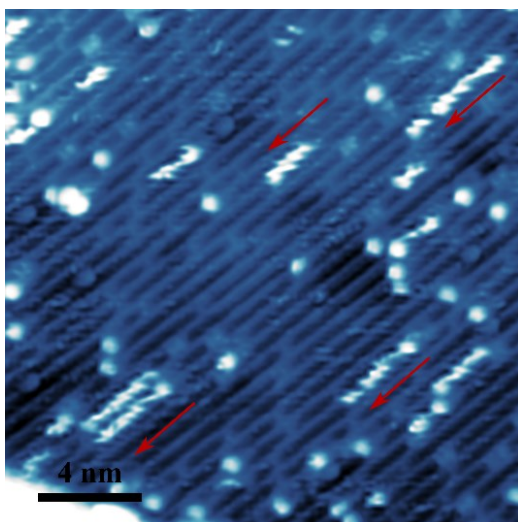
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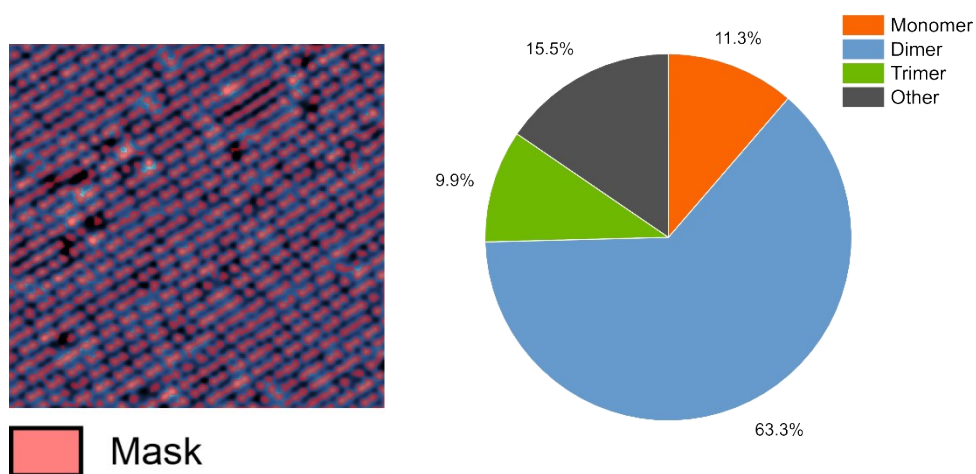
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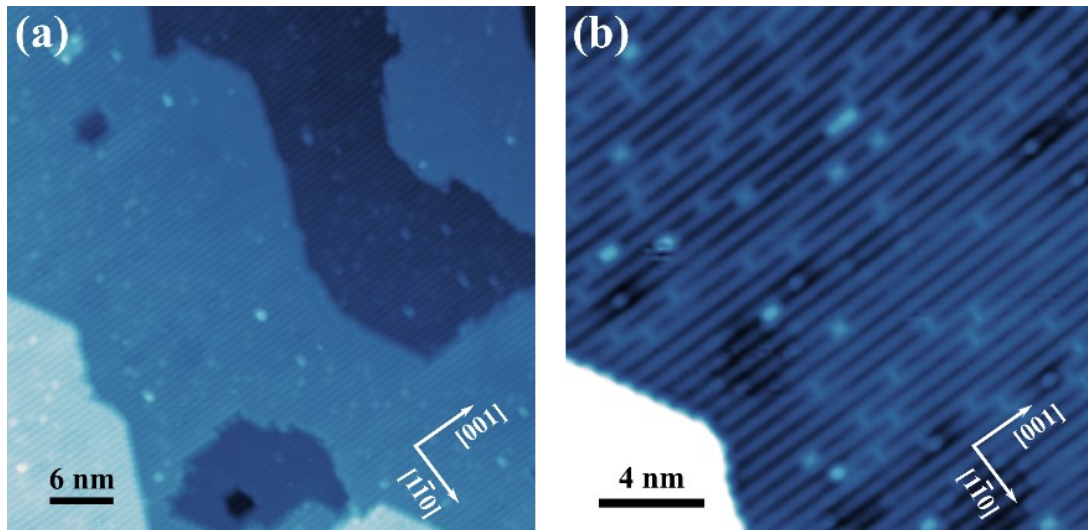
**Figure S1.** (a) STM image of just-prepared  $\text{TiO}_2(110)$  surface. Image size: 50 nm×50 nm. Image condition:  $U=1.0$  V,  $I=110$  pA. (b) Atomic resolution of cleaned  $\text{TiO}_2(110)$  surface. Image size: 8 nm×8 nm. Image condition:  $U=0.6$  V,  $I=180$  pA.



**Figure S2.** STM image of  $C_2H_2$  molecules migration along surface  $Ti_{5c}$  rows. (Indicated by the red arrow). Image size:  $20\text{ nm}\times 20\text{ nm}$ . Image condition:  $U=1.1\text{ V}$ ,  $I=100\text{ pA}$ .



**Figure S3.** The fraction of different surface clusters counted by measuring the cluster size. (monomer:  $<0.1\text{ nm}^2$ , dimer:  $0.1\sim 0.2\text{ nm}^2$ , trimer:  $0.2\sim 0.3\text{ nm}^2$ ). It shows that more than 60% of the surface was covered by  $C_2H_2$  dimer. While the monomers and trimers are both about 10% on the surface. Others are the clusters which are larger than trimer.



**Figure S4.** STM image of  $C_2H_2$  covered  $TiO_2(110)$  surface annealed to room temperature. (a) Image size: 50 nm $\times$ 50 nm. Image condition:  $U=1.1$  V,  $I=120$  pA. (b) Image size: 20 nm $\times$ 20 nm. Image condition:  $U=1.1$  V,  $I=130$  pA.