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Period -Doubling Perturbation Induced by Defects on In/Si(111)-4×1 Surface

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Recently, Indium on Si(111) surface has attracted much attention since the discovery of a phase transition of the 4×1-In surface at room temperature (RT) into the 4×2 (or 8×2) phase below 130 K [1]. Peierls instability and formation of a charge density wave (CDW) of this quasi-one-dimensional structure was proposed as a mechanism. The surface was also reported to undergo the 4×1-to-4×2 phase transition even at RT upon Na adsorption by pinning the CDW condensate near the Na atoms [2].

We have investigated defect-induced perturbation on the Si(111)4×1-In surface using scanning tunneling microscopy (STM) and Ab-initio pseudopotential calculations. A period-doubling (×2) modulation in the row direction, independent of the applied voltage, was observed near various types of defects on the 4×1-In surface at RT. This ×2 modulation differs not both in appearance and in electric property from those of low-temperature (LT) 4×2 phase and Na-induced perturbation at RT. The ×2 modulation in STM images is prominent for low bias voltages but becomes weak with increasing voltage. It is found that a small-amplitude, x2 lattice distortion is induced near the defects, but the observed modulation is mainly electronic since the electrons near the Fermi level are mostly affected. This symmetry-broken structure contrasts to the Na-induced structure, in that it does not mimic the LT phase of the defect-free system.

[References]

[1] H. W. Yeom *et al.*, Phys. Rev. Lett. 82 (1999) 4898.

[2] S. S. Lee *et al.*, Phys. Rev. Lett. 88 (2002) 196401.