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An atomic switch of electron propagation on Ge (001) by tunneling carrier injection

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Reversible switching of electronic conduction through atom manipulation is one of the important subjects of nanoscience. However, different conducting pathways were not clearly observed with atomic resolution. We have demonstrated the correlation between the change of surface atomic position by tunneling carrier injection and that of the reflection of one-dimensional (1D) surface-state electrons on the Ge (001) surface with a low density of heterogeneous Sn-Ge dimers. [1] On the clean Ge(001) surface, two adjacent atoms form a buckled dimer, and the buckling orientation of the Ge dimer can be locally and reversibly controlled by carrier injection to the surface from the STM tip. [2] The unoccupied surface π^*-electron behaves like a 1D free electron along the Ge dimer row. When Sn atoms are deposited on the clean Ge(001) surface at room temperature, buckled dimers originating from the Sn atoms are formed at the Ge dimer position in the surface. [3] An atomic switch is realized for the π^* electrons in the Ge dimer- row direction by injection carriers to reversibly flip the buckling orientation of a single Sn-Ge dimer in the dimer row. When the Sn atom of the heterogeneous dimer is at the lower position, the 1D electrons are reflected and a standing wave of this state is observed. Whereas, when it is at the upper position, the 1D electrons pass through the heterogeneous dimer, and no standing wave is observed. In this state, the lower atom of the dimer is Ge, and the π^* state at the dimer is little different from that of the Ge-Ge dimers.

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[3] K. Tomatsu, K. Nakatsuji, T. Iimori, F. Komori; Surf. Sci. **601**, 1736, 2007.