Mechanical properties of Pt-Pt bond in an atomic chain measured by TEM combined with a frequency-modulation force sensing system

Japan Adv. Inst. Sci. & Technol.[1],

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The bonds between two metal atoms are of utmost importance in physics and chemistry for understanding the formation and various properties of metal nanostructures. [1] However, the mechanical property of the bonds in a chain has not been investigated much although it has broad fundamental interest and great potential applications, including atomic-scale understanding of tribological phenomena, atomic manipulation and shape stability of nm nanomaterials. In this study, for measure the effective spring constant of Pt atomic chain, we employed a transmission electron microscope (TEM) combined with a frequency-modulation force sensing system, which was used for non-contact atomic force microscopy.

We use TEM combined with a quartz length-extension resonator (LER) to resolve the stiffness of platinum (Pt) atomic chains by measure the frequency shift of LER. The atomic configurations can be obtained from the TEM image captured during the conductance and stiffness measurement (fig. 1). We found that the stiffness of an atomic chain various with the number of atoms in a chain according to the histogram (fig. 2). After removal of the contribution of the base part [2], the stiffness of a bond between two Pt atoms can be identified. We found the stiffness of a Pt-Pt bond in a Pt atomic chain depend on the type of composed atoms (with or without edge atom). The direct measurement of the Pt bond stiffness paves the way for the development of atomic scale manipulation.

[1] Y. Oshima and K. Kurui: Phys. Rev. B 87 (2013) 081404.

[2] K. Ishizuka et al: Appl. Phys. Express accepted

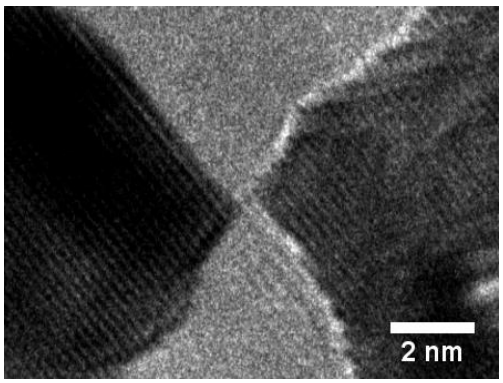

Fig. 1 TEM image of the Pt atomic chain.

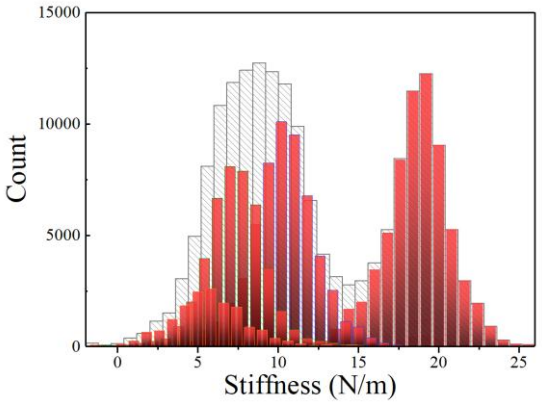

Fig. 2 Stiffness histogram of the atomic chains.

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