Ad-dimer structure of diamond (001) surfaces in atomic resolution

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Diamond is expected to be utilized in the next generation of power devices due to its wide band gap, high carrier mobility, and high thermal conductivity. Film growth with controlled doping levels is a prerequisite for device fabrication. Therefore, the surface structure of the grown film is also important, as it carries the clue to the film growth process. However, the difficulty in detecting individual carbon atoms [1-3] limits the precise determination of surface defects.

We investigated the surface of diamond (001) films using non-contact atomic force microscopy (AFM) at room temperature. Boron-doped homoepitaxial diamond thin films were grown by the chemical vapor deposition method [4]. The sample surfaces after the growth were hydrogen-terminated, and clean surfaces were prepared by annealing at 1020℃ in an ultrahigh vacuum chamber (UHV). The individual atoms were visualized for the first time by re-ordering the surface C-C bonds to the Si cantilevers [5]. In addition, carbon atoms form dimers on the diamond (001) surface, forming a (2×1) reconstructed surface. We clarified that the adsorbed dimers (ad-dimers) arrange into one-dimensional rows [Figure 1]. First-principles calculations also manifest that such ad-dimers are energetically stable.

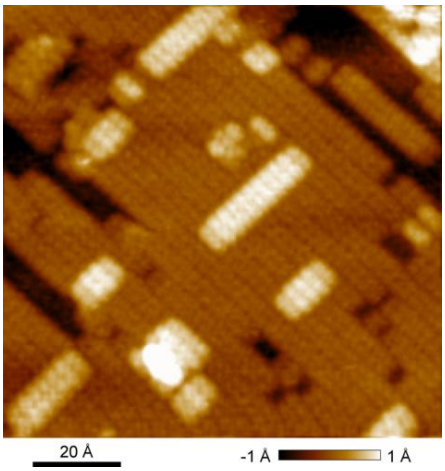

Figure 1. Topographic image of a diamond (001) surface showing the ad-dimer structures [6].

Reference

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