Surface structures and electronic states of clean and H_2S-treated GaP(001), InP(001), and InAs(001) surfaces

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Ⅲ-V compound semiconductors have been widely studied to apply for optical and high speed devices. As the density of devices increases, it will be necessary to manipulate atoms in the devices. However, the compound surface structures in atomic scale are not clarified at present. These devices suffer from instabilities at the surfaces in their characteristics. To improve the surface electronic properties, passivation of the surfaces with sulfur has been studied. However, the surface structures and electronic states are still equivocal. In this thesis, the geometric and electronic structures of clean and H_2S-treated GaP(001) ,CInP(001), and InAs(001) surfaces are studied by scanning tunneling microscopy (STM), photoemission spectroscopy(PES), and inverse photoemission spectroscopy (IPES).

It is elucidated by STM that GaP(001)-(4×2) and InAs(001)-(4×2) clean surfaces consist of 2-Ga-dimer 2-missing-row-dimer and 1-In-dimer 3-missing-row-dimer structures, respectively. On the other hand, the STM images of the InP(001)-(4×2) clean surface can not be explained by existing models. Therefore, I propose a new model including a heterodimer, P-In, at the first layer.

H_2S-treated GaP(001)-(1×2), InP(001)-(1×2), and InAs(001)-(1×2) surfaces are studied by STM and PES, and the surface geometric structures are clarified. In addition, it is found by PES and IPES that surface states of the clean surfaces are decreased drastically by H_2S treatments.