

STM / STS measurements of Mn atoms in Group III-V semiconductors

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Diluted magnetic semiconductor (DMSs) are semiconductors doped with magnetic atoms. For practical use, it is necessary to clarify the electronic states around the magnetic atoms. Recent scanning tunneling microscopy (STM) measurements revealed the hole state bound to a Mn acceptor in III-V semiconductors such as GaAs[1], InAs[2] and InSb[3]. It was shown by STM that the hole state bound to a Mn acceptor in III-V semiconductors has a strongly anisotropic shape which is even more pronounced at cleaved (110) surfaces. This anisotropy is caused by the strain field of the surface relaxation and the tip-induced electric field[4]. Also, it is known that the appearance of the STM image changes depending on the depth of the acceptor level. At a fixed depth, the charge distribution of a deep acceptor, such as Mn in GaAs and InAs, is characterized by a bow-tie shape whereas the shape of the charge distribution of a shallow acceptor, such as Zn in GaAs and Mn in InSb, is triangular.

In this study, we focus on GaSb:Mn which had not reported STM images so far. The binding energy of GaSb:Mn is smaller than that of InAs:Mn and larger than that of InSb:Mn. We predicted that the STM image of GaSb:Mn appears more triangular than InAs:Mn. We grew InAs:Mn and GaSb:Mn on a S-doped InAs substrate by molecular beam epitaxy. The sample was cleaved in UHV and was observed at a low temperature of around 78K using a STM system with a W-tip in UHV($\sim 10^{-10}$ Torr). For comparison, we also measured GaAs: Mn. Fig. 1 shows typical STM images of Mn atoms in GaSb as well as those in GaAs and InAs. The STM image of Mn in GaSb is rather diffused compared with those in GaAs and InAs, and the STM image of GaSb: Mn has a triangular shape as expected. In the presentation, we will also discuss the difference of energy profile of local density of states obtained by scanning tunneling spectroscopy (STS) measurements.

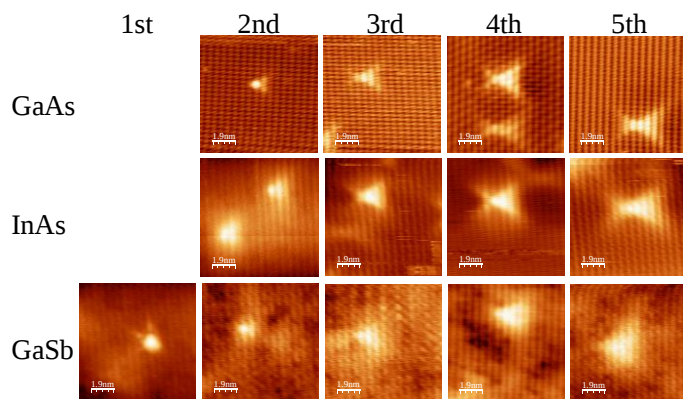


Fig. 1 STM images of Mn in GaAs, InAs and GaSb, at different layer depths

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