Atomic scale analysis of N dopants in InAs

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The band gap of most III-V semiconductors is strongly reduced with the introduction of only a few percent of N, even if the III-N alloy has a much bigger band gap. N impurities in InAs introduce an impurity state around 1 eV above the conduction band minimum, much deeper in the band than in other III-V materials. Topographic scanning tunneling spectroscopy measurements (STS) and areal spectroscopy measurements performed on N atoms up to two layers below the (110) surface of InAs show a reduction of the resonance energy of the N atom with increasing depth. This is attributed to tip induced band bending, pulling the N states up at positive bias and acting most strongly on surface N atoms. An example of STM images on InAs:N is shown in figure 1. STS measurements obtained on undoped InAs and N-doped InAs show a band gap reduction of <0.1 eV. Spacial imaging of features corresponding to N dopants up to two layers below the surface are also compared to density functional theory simulations and show excellent correspondence. Spectroscopy maps of N atoms up to two layers below the surface provide a high resolution spatial and spectroscopic view of the N atoms. Here the characteristic shape of the N atoms in different layers below the surface is observed as an enhancement of the dI/dV signal compared to the InAs background. At energies above the enhancement a reduction of the dI/dV is observed, which has the same shape and size as the enhancement. This shows that the redistribution of density of states caused by the N impurities is mainly energetic in nature.

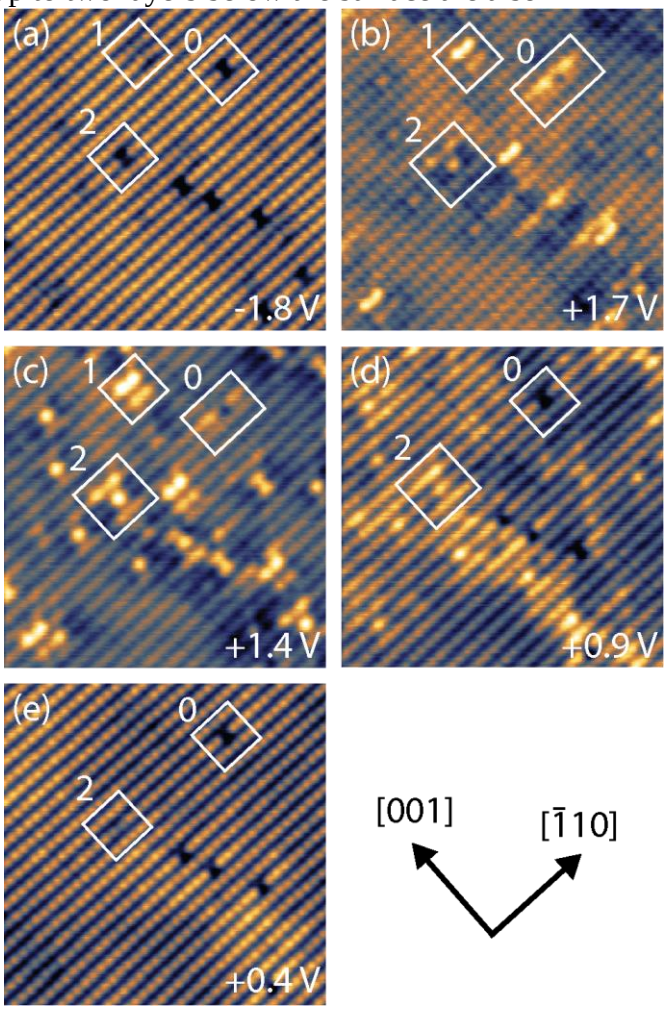

Figure 1 STM images of InAs:N at different voltages. (77K, 50pA)