The Waterloo Institute for Nanotechnology

Presents

Nanometer Thick Membranes as Substrates for InAs Growth

Dr Christoph Deneke
Scientific Head
Laboratory for Surface Science
Brazilian Nanotechnology National Laboratory (LNNano)/CNPEM
Brazil

Freestanding membranes have attracted great attention in the last decade [1,2], sometimes being called the “third wave” of nanotechnology [3]. Inspired by the early works on compliant substrates [4], such freestanding membranes have been used as substrates for self-assembled Ge growth on Si [5].

We extended this technique from Ge self-assembled structures to the group of III-V semiconductors. In a first work [6], self-assembled InAs growth on freestanding Si membranes was investigated. Therefore, SiO samples were pre-patterned to obtain freestanding Si membranes and overgrown using III-V molecular beam epitaxy (MBE). We find that the InAs deposition influences the compliant Si membrane and the InAs island formation changes from the fixed parts to the freestanding parts. The strain transfer of the islands causes a buckling up of the freestanding membrane. Furthermore, the InAs island density decreases on top of the freestanding parts in comparison to fixed, ridged areas of the sample. Diffraction experiments in combination with finite element calculations allow the investigation of the InAs island strain state. The results indicate that the strain relaxation of the islands depends on the membrane position.

In a second work [7], we partly released a strained In0.3Ga0.7As layer from its patterned substrate allowing it to relax and wrinkle. In this way, we obtain a substrate exhibiting two different lattice parameters as well as areas of high substrate curvatures. The samples are cleaned and a systematic growth study by depositing InAs on to the single crystalline surface in our MBE machine was carried out. We observe a large InAs migration from the unreleased areas towards the released, wrinkled areas of our structures. AFM images show that the material accumulates either at the edges between the unreleased and released areas or on top of the wrinkled structures. This InAs migration can be explained by analyzing the local lattice parameter and therefore the misfit strain between the deposited material and the substrate.