Selective area epitaxy of InAs/AlGaSb tunnel diodes

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The AlGaSb/InAs heterostructure is a very promising system for tunnel field effect transistors (TFET) as its highly staggered band line-up can lead to a tunnel current density as high as 1 MA/cm^2. Various configurations have been used to control the tunneling current through the InAs/(Al)GaSb heterostructure from gate all around vertical nanowires grown in the (111) direction to planar gate controlling the vertical tunneling of charges. Those devices exhibit promising characteristics in term of ON-state current density but may be further improved to achieve a sub-threshold slope well below 60 mV/decade. In this study, selective area (SA) growth of InAs by molecular beam epitaxy (MBE) is used to define small area near broken gap AlGaSb/InAs tunnel diodes grown on a GaSb:p+ (001) substrate. Combining PECVD, e-beam lithography, RIE and chemical etching, apertures in a SiO_2 layer deposited at the surface of the wafer are designed and serve as a mask for the selective epitaxy of InAs nanostructures. The tunneling heterojunction is achieved by growing AlGaSb/GaSb over the InAs nanostructure. The current-voltage curves of the vertical diodes exhibit a negative differential resistance characteristic of an Esaki diode. The peak current density is larger than 1 MA.cm^{-2} for 2µmx2µm diodes but is reduced to a few tens of kA.cm^{-2} for 50 nmx50 nm SiO_2 apertures. This phenomenon is attributed to the particular incorporation of Si dopant with respect to the facets of the InAs nanostructure [1].

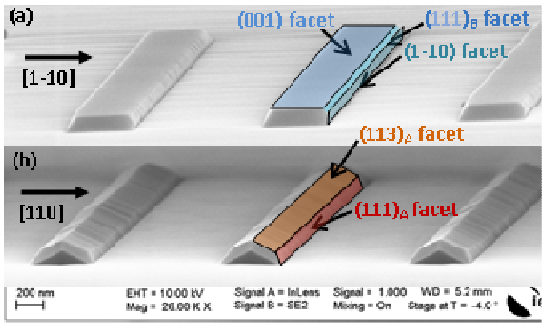

Figure 1 – SAMBE of InAs nanostructures on GaSb

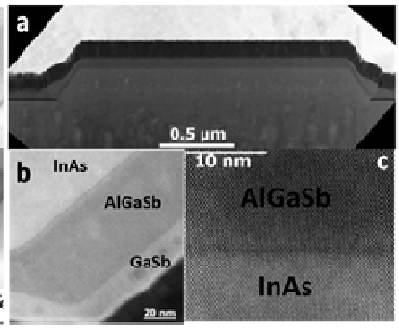

Figure 2 – InAs/AlGaSb heterojunctions

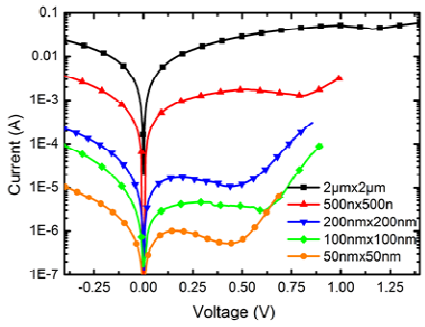

Figure 3– Current-voltage characteristics of tunnel diodes

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[1] L.Desplanque *et al*, ***Nanotechnology* 25**, 465302 (2014)

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