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Technical Program with Abstracts
The reverse process of an epitaxial growth, i.e., the chemical etching of the initial InP substrate. The experimental results clearly show how a mesa relax both by gliding its edges and by buckling its central area. The competition between these two relaxation processes is discussed via recently published theoretical backgrounds. Finally, we will discuss what can be issued from this theoretical-to-experiment confrontation in terms of compliance understanding and feasibility.

**10:20 AM Student**

E2, High Ge-Content Relaxed Si$_x$Ge$_{1-x}$ Layers by Relaxation on Compliant Substrate with Controlled Oxidation: Hai Zhou; Yin; Karl D. Hobart; Rui Huang; Jim Liang; Zhiqiang Suo; Sean R. Shieh; Thomas S. Duffy; James C. Sturm; *Princeton University, Electr. Eng., Princeton, NJ 08544 USA; The Naval Research Laboratory, Washington, DC 20375 USA; *Princeton University, Princeton, NJ 08544 USA; *Princeton University, Princeton, NJ 08544 USA; *Princeton University, Princeton, NJ 08544 USA.

There has been increasing interest in compliant substrates for integration of heterogeneous epitaxial materials. In this talk, borophosphosilicate glass (BPSG) on silicon is used as a compliant substrate to allow the relaxation of strained SiGe islands, a process which can allow relaxed layers to be obtained without the formation of misfit dislocation observed in graded SiGe buffers. Previous work has shown that relaxed SiGe on Si by this method is limited to small islands (less than 30 microns) and low Ge fraction (less than 30%), with the buckling of the compressive SiGe layers as a fundamental limit. In this paper, we describe two key improvements to allow 200 micron islands with up to 65% Ge to be relaxed: (i) oxidation of the SiGe layers to increase the Ge fraction, and (ii) the use of a deposited oxide to prevent buckling and control the oxidation rate. A wafer of 30nm-strained Si$_{0.4}$Ge$_{0.6}$/25nm-Si/200nm-BPSG/Si was fabricated by bonding and Smart-cut as before. SiGe islands of sizes 10-30microns were then patterned. Long anneals at 875°C were carried out to achieve intermixing of Ge and silicon in the islands, which yielded relaxed 5nm-thick Si$_{0.4}$Ge$_{0.6}$ islands. Raman spectroscopy was used to independently determine both the Ge content and strain status of SiGe islands. This sample was oxidized from 800°C to 960°C to raise Ge content due to preferential thermal oxidation of Si atoms in the alloys. Two problems emerged during the oxidation process: (1) Surfaces of islands buckled due to the strain increase from higher Ge content and the island thinning; (2) the uniformity of Ge content across islands was poor, because the surface Ge content of islands is believed to determine the interface oxidation reaction and it is difficult to control the surface condition as Ge snowplows into the alloy during oxidation. A layer of FECVD oxide on the top was used to solve these problems. It effectively increases the island thickness, making them stiffer and consequently less prone to buckling. Furthermore, the effect of the SiGe surface on oxidation is removed, because the oxidation process is now largely limited by the diffusion of oxygen through the top oxide. The oxidation rate can be well controlled by the thickness of the oxide layer. Without this capping layer, a lateral lattice constant larger than that of a relaxed Si$_{0.4}$Ge$_{0.6}$ on 200nm islands could not be achieved due to buckling and oxidation rate variations. However, with the capping process, uniform 200nm islands with fully relaxed Si$_{0.4}$Ge$_{0.6}$ were achieved. In smaller fully relaxed islands Ge content over 70% has been achieved. This is far higher than the effective Ge substrate content (the i.e. the in-plane lattice constant of a relaxed layer) of Si$_{0.4}$Ge$_{0.6}$ previously reported using the oxidation technique. This work is supported by DARPA and ARO.

**10:40 AM**

E3, Strain Relaxation in Wafer-Bonded SiGe/Si Heterostructures Due to Vicous Flow of an Underlying Borosilicate Glass: Peter Mordue; K. D. Hobart; *Michigan Technological University, Michigan Tech, SCS Dept., 408 MME Bldg., Houghton, MI 49931 USA; The Naval Research Laboratory, Washington, DC 20375 USA.

We report a high-resolution x-ray diffraction (HRXRD) study of relaxation in a strained semiconductor heterostructure removed from its native substrate, bonded to a glass substrate, and subsequently heated. The data is consistent with the type of relaxation that would result from viscous flow of the underlying glass. It is not consistent with the type of relaxation that would result from an enhancement in misfit dislocation nucleation and/or threading dislocation glide due to a sub-surface bonded.