

NAMBE

Room Cummings Ballroom - Session NAMBE3-MoA

Late News I

Moderator: John McElearney, Tufts University

4:30pm **NAMBE3-MoA-13 James S. Harris NAMBE Student Paper Awardee Talk,**

5:00pm **NAMBE3-MoA-15 Interfacial Misfit Arrays in Ternary III-V Compounds for Virtual Substrates on Si with Arbitrary Lattice Constant,** Trent Garrett, Boise State University; J. Rushing, Tufts University; J. Tenorio, Boise State University; P. Simmonds, Tufts University

Lattice constants of the III-V semiconductors range from 5.45 Å (GaP) to 6.48 Å (InSb). III-V semiconductors are grown on commercially available substrates made from binary III-V materials (e.g., GaAs, InP, and GaSb), or group IV materials (e.g., Si or Ge). These substrates offer very high quality, but only offer access to a small number of specific lattice constants. Given this constraint, it is desirable to develop growth methods that allow the grower to modulate from the substrate lattice constant into the lattice constant of the material structure under investigation.

Structures lattice-mismatched to these substrates can be challenging to grow due to the deleterious effects of strain relaxation on their electronic and optical properties. One way to overcome this limitation uses metamorphic buffers to gradually adjust the lattice constant from that of the substrate to that of the desired III-V compound. Metamorphic buffers are frequently much thicker than the device structure grown on top, adding time and expense to the overall growth.

An alternative way to accommodate lattice mismatch involves interfacial misfit (IMF) arrays. These 2D networks of 90° misfit dislocations lie in the substrate/III-V interface and efficiently relieve the strain. Careful control of this process can limit the density of 60° threading dislocations extending away from the interface, helping protect the quality of layers grown above. To date, the IMF process has been studied in only a few “virtual substrate” systems, notably GaSb on GaAs and on Si, which crucially both still only offer access to a fixed lattice constant of ~6.1 Å.

Motivated by producing virtual III-V substrates with any lattice constant, we have expanded the IMF approach to enable growth of ternary compounds. Due to the benefits of Si substrates (availability, cost, scalability, and ease of integration with Si electronics) we chose as a starting point the GaSb-on-Si IMF system. For lattice constants > 6.1 Å we have explored IMF-based MBE growth of ternary $\text{Al}_{1-x}\text{In}_x\text{Sb}$ and $\text{Ga}_{1-x}\text{In}_x\text{Sb}$ compounds directly on Si substrates. Similarly, for lattice constants < 6.1 Å we have explored IMF-based $\text{AlSb}_{1-x}\text{As}_x$ and $\text{GaSb}_{1-x}\text{As}_x$ grown on Si. By varying their composition, we have grown ternary buffers with lattice constants ranging from 6.05 – 6.4 Å. We will present preliminary results discussing their structural properties.

We believe this approach will produce high quality, ternary III-V-on-Si virtual substrates. By choosing the lattice constant in advance, these virtual substrates will enable users to grow a wide range of III-V structures without strain, impacting device applications from LiDAR to LWIR.

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