NAMBE
Room Cummings Ballroom - Session NAMBE3-MoA

Late News I
Moderator: John McElearney, Tufts University

4:30pm **NAMBE3-MoA-13 James S. Harris MBE Scientific Discovery Awardee Talk: MBE Growth of GaN: From Novel Growth to Record Performance Materials and Devices***, James Speck,* University of California, Santa Barbara

By the mid-to-late 1990s, growth of GaN by MBE was in disarray with little promise of realization of materials with quality comparable to those already developed MOCVD. In this presentation, we provide an overview of the progression of plasma-assisted MBE (PAMBE) and NH3 growth of GaN. The highest quality materials in PAMBE growth are typically realized with a saturated chemisorbed metal adlayer (~2 - 2.5 ML of Ga) on the surface. Challenges with metal droplet formation can be suppressed by metal modulated growth in which periodic growth interrupts or reduced Ga flux suppress the formation of large Ga droplets. Record electron mobilities were realized by realized by higher temperature growth in the intermediate growth region. Many of features of today's GaN HEMTs were developed by PAMBE including the widely used AlN interlayer at the AlGaN/GaN interface to reduced alloy scattering and compositional grading to realize three dimension electron gases (3DEGs) from gradients in electrical polarization. NH3 MBE has been extensively for both lateral and vertical devices. Highlights of NH3 work include record electron mobilities, outstanding pn junctions with record low ideality factor.

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 90º misfit dislocations lie in the substrate/III-V interface and efficiently relieve the strain. Careful control of this process can limit the density of 60º 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 $Al_{1-x}In_xSb$ and $Ga_{1-x}In_xSb$ compounds directly on Si substrates. Similarly, for lattice constants < 6.1 Å we have explored IMF-based $AlSb_{1-x}As_x$ and $GaSb_{1-x}As_x$ 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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