PCSI

Room Ballroom South - Session PCSI-2WeM

Topological Materials II

Moderator: Lincoln J. Lauhon, Northwestern University

11:00am **PCSI-2WeM-31 Epitaxial Nitride Semiconductor/Superconductor Heterostructures***, **Debdeep Jena**,* Cornell University **INVITED**

A new development in MBE growth of lattice-matched NbN/AlN/GaN heterostructures has allowed the integration of GaN based high-electron mobility transistors (HEMTs) with MBE grown NbN superconductors. Structural and electronic properties of these heterostructures and the effect of interfaces will be discussed. Attempts to obtain the quantum Hall effect in the 2DEGs epitaxially grown on the superconductor will be discussed. Finally, progress towards the MBE growth of NbN/AlN/NbN Josephson junctions will be reported.

11:30am **PCSI-2WeM-37 Wafer Bonding Approach for Epitaxial Al/GaAs(001)/Al Tri-layers***, **Anthony McFadden**, M Seas,* University of California, Santa Barbara*; C McRae, R Lake,* National Institute of Standards and Technology*; J Wen, J Wang, I Arslan,* Argonne National Laboratory*; D Pappas,* National Institute of Standards and Technology*; C Palmstrøm,* University of California, Santa Barbara

Superconductor-insulator-superconductor (Josephson) junctions utilizing amorphous oxide barriers have been studied extensively, however relatively little work has been done using single crystal semiconductors in place of amorphous oxide barriers. This is likely due to difficulty in fabrication of such structures including symmetry mismatch of the semiconductor to the superconductor and the reactions and roughening that may occur at the temperatures needed for semiconductor growth. This work focuses on a wafer bonding approach, subsequent substrate removal, and superconductor regrowth for fabrication of Al/GaAs(001)/Al Josephson junctions. AlGaAs/GaAs/Al structures are grown by molecular beam epitaxy on GaAs(001) substrates and wafer-bonded to Si. The substrate and sacrificial AlGaAs layers were removed by selective wet etching followed by surface cleaning in ultrahigh vacuum and aluminum regrowth. The wafer bond and Al/GaAs interfaces are studied by transmission electron microscopy (TEM). X-ray photoelectron microscopy (XPS) is used to determine GaAs surface cleaning conditions compatible with the wafer bonding process following substrate removal. X-ray diffraction (XRD) and reflection high energy electron diffraction (RHEED) is used to assess crystalline quality and orientation of the epitaxial aluminum.

11:35am **PCSI-2WeM-38 Growth and Nucleation of Low-Loss Titanium Nitride Superconductors on Silicon (111) using Plasma Assisted MBE***, **Chris Richardson**, A Alexander, C Weddle,* University of Maryland*; B Arey, M Olszta,* Pacific Northwest National Laboratory

Titanium nitride (TiN) is a known superconducting material that has demonstrated low-microwave-loss and used as passive components in superconducting quantum circuits for quantum information devices [1]. In contrast to conventional synthesis techniques, plasma assisted molecular beam epitaxy is used to produce low-loss TiN on bare silicon wafers. Using a rf-plasma source to crack the nitrogen molecules, and a conventional high temperature effusion cell for titanium, TiN growth is completed under nitrogen rich conditions to produce polycrystalline thin films that sit on an amorphous nitride layer. The motivation and activities pursued to synthesize epitaxial TiN on silicon that is compatible with the requirements of superconducting quantum circuits will be discussed.

A number of techniques are used to characterize the structure of the material, while cryogenic tests down to 80 mK characterize the superconducting properties. Coplanar waveguide resonators operating at 5 GHz demonstrate single photon quality factors above 1M, and high-power quality factors that approach 7M without observing saturation.

REFERENCE:

[1] J. B. Chang, M. R. Vissers, A. D. Córcoles, M. Sandberg, J. Gao, D. W. Abraham, J. M. Chow, J. M. Gambetta, M. B. Rothwell, G. A. Keefe, M. Steffen, and D. P. Pappas, *Appl. Phys. Lett.* **103**, 012602 (2013).

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