

Challenges in III-V on Si Integration: Equipment, Process and Device

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ABSTRACT

Recently heterogeneous integration of III-V semiconductors epitaxially grown on Si has attracted a great amount of interest due to the possibility of combining the superior electronic and optoelectronic properties of III-Vs, with the high manufacturability of Si-based microelectronics. Moreover, the growth of III-V semiconductors on Si with high effective mobility and injection velocity, like InGaAs and InAs, are considered promising candidates to replace Si as the channel material in sub-7 nm node CMOS devices. The large lattice and thermal expansion coefficient mismatch, along with the difference in crystal polarity between III-Vs and Si, results in the generation of crystalline defects in heteroepitaxial layers which can deteriorate device performance and reliability. For III-V materials to become a realistic option for sub-7nm CMOS devices, growth on 300mm Si wafers meeting CMOS defect density and electrical performance must be realized.

In this talk, among all the techniques meant to reduce defect density, two main approaches are being extensively explored to grow III-V films on Si : the use of strain relaxed buffer layer (SRB) approach as blanket deposition, and the so-called III-V replacement fin approach, also known as aspect ratio trapping (ART) as selective area growth. In this paper, we study the impact of different buffer layers on both SRB and ART approaches on the crystal quality of InGaAs films, grown by MOCVD on 300 mm Si (001) wafers.

Irrespective of the approaches for defect reduction, MOCVD processes has to be developed on 300mm wafers demonstrating good physical and device properties. Moreover, a MOCVD equipment is required for HVM manufacturing which offers low cost of ownership, high reliability and uptime, as well as ES&H compatibility. Thus, a MOCVD equipment with close coupled showerhead technology along with other equipment features will also be presented in this seminar.

Bio : Zia Karim, Ph.D.

Zia Karim is currently Vice President of Business Development and Global Customer Support in AIXTRON, a leading Semiconductor Equipment Company for LED, Memory and Power Devices. Dr. Karim has held senior management positions (Director/Sr. Director) in AIXTRON, Applied Materials, and Novellus after he started his career in Sharp Microelectronics in 1994.

Dr. Karim took a pioneering role in positioning III-V MOCVD process for High Mobility Channel Applications in Semiconductor Devices. Other than leading the product and process development for MOCVD III-V growth in AIXTRON since 2005, Dr. Karim organized and moderated "III-V on Si" Seminars jointly with Sematech at every pre-IEDM from 2006 to 2012. Dr. Karim owns fourteen (14) patents. Other than Organizing or co-organizing several Conference Symposiums and related Transactions, Dr. Karim also authored more than thirty (30) published papers in peer-reviewed journals.