There have been tremendous advances in integration of compound semiconductors on Si. While research efforts has been more focused on electronics applications, but immense opportunities lies in optical and optoelectronics integration as well. Although initial efforts in past decade has been on traditional semiconductors such as GaAs and InP on Si, but lately there has been intense activities on integration of nitride semiconductors on Silicon. MBE and MOCVD bring its own set of challenges and opportunities some of which are from its legacy, but also they impart novel flexibilities based on applications. Details relevant to integration of compound semiconductors on Si, will be presented in the context of Beyond-Moore’s challenges that will be instrumental in creation of new enablers through epitaxial engineering where the advantages of MBE are complementary to disadvantages of MOCVD and vice-versa.

Past and present major research programs thrusts on integration of compound semiconductor on Si, across the globe will be discussed. The COSMOS program was driven by DARPA with compound semiconductor industry key players leading the show, which was later followed by DAHI program. Micro-assembly, monolithic epitaxial growth and epitaxy layer bonding process has been the final goals for the integration schemes within these efforts. Elsewhere, such as in India, major efforts have been underway by Government at IIT Kharagpur (extensive laboratory set up by the author) through focus on heterointegration by cluster tool MBE and MOCVD for electronics and optical devices respectively based on 6” manufacturing platform. Bandgap engineering and Metamorphic growth are the drivers here for creation of high performance compound semiconductor heterostructures combining optimization of high power, high linearity, high frequency, high efficiency, low Ron, and low noise performances of III-V devices on silicon for “Beyond-Moore’s epitaxial devices”. Comparative analysis of the deliverables and implementations will be presented for epitaxial heterostructures on Si, grown by MBE and MOCVD.

The paper will also elaborate the comparative physics of the growth mechanisms including characterization of epitaxial structures and device properties of compound semiconductors on Si by MBE and MOCVD. The nontrivial effect of heteroepitaxial schemes due to specialties of MOCVD and MBE growth processes on epitaxial properties of III-V on Si due will be discussed with emphasis on high volume manufacturing of bipolar, FETs and LEDs. Particularly in nitride integration on Si, latest MOCVD technologies and comparative MBE processes to grow graded nitride epitaxial structures to address wafer bowing and planarity will be discussed, while metamorphic buffers and dilute alloy systems that will be crucial to solve thermal conductivity, reduced mismatch and low defect structures with adequate high resistive buffer necessary for appropriate mixed signal devices will be presented.

Comparative advances in growth processes will be used sometimes as basis for template and active layer formations and its combination thereof to reduce costs with maximum yield meeting demanding device targets. In conclusion, future trends of such emergent technologies of electronic and optical devices driven by the manufacturing excellences of MBE and MOCVD for epitaxial integration on Silicon will be presented.