IMEC demonstrates growth of GaN high-electron mobility transistors on 150 mm silicon

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IMEC, Europe's leading independent nanoelectronics and nanotechnology research institute, has demonstrated the growth of low-sheet-resistivity AlGaN/GaN high-electron mobility transistors (HEMTs) on 150mm silicon (Si) wafers. The process paves the way to low-cost GaN power devices for high-efficiency/high-power systems beyond the silicon limits.

The high-quality AlGaN and GaN layers were grown in IMEC's new 150mm metal-organic chemical vapor-phase epitaxy (MOVPE) system. This infrastructure extension allows IMEC to offer access to its AlGaN/GaN epiwafers in a service mode to laboratories and partner companies.

For the first time ever, excellent uniformity results have been obtained for the growth of HEMTs on 150mm Si wafers. HEMT structures with a sheet resistivity as low as 272±5 O/square and a standard deviation as small as 1.9% (edge excluded) have been demonstrated.

The process overcomes current problems associated with the growth of high-quality epitaxial GaN layers on Si. These problems result from the high lattice mismatch and the large difference in thermal expansion coefficient between Si and GaN. An AlGaN buffer layer has been successfully introduced to provide compressive stress in the top GaN layer. This, in combination with an IMEC proprietary in-situ Si3N4

passivation layer, results in superb HEMT devices on Si.

Due to the lack of commercially available GaN substrates, GaN heterostructures are nowadays grown mainly on sapphire and silicon carbide (SiC). Si is a very attractive alternative due to its very low cost compared to sapphire and SiC. Other benefits include the acceptable thermal conductivity of Si (half of that of SiC) and its availability in large quantities and large wafer sizes.

The high-quality epitaxial AlGaN and GaN layers were grown in IMEC's new 150mm metal-organic chemical vapor-phase epitaxy Thomas Swan Close-Coupled Showerhead reactor (MOVPE) system, in the framework of an European Space Agency (ESA) project called Epi-GaN.

Marianne Germain, director of IMEC's Efficient Power Program: "This reactor is a very valuable extension of our existing 3x2" system, as it increases both growth capacity and wafer size (up to 150 mm). The infrastructural extension allows IMEC to offer access to its AlGaN/GaN epiwafers in a service mode to laboratories and partner companies involved for the development of their GaN device applications. The results proof the capability of IMEC to grow HEMT epiwafers with excellent quality, good uniformity and high reproducibility."

Specifications on epiwafer characteristics available through this service can be obtained at IMEC on demand. AlGaN/GaN HEMT epiwafers can be grown on sapphire, SiC or Si substrates.

Gallium nitride (GaN) has outstanding capabilities for power, low-noise, high-frequency, high-temperature operations, even in harsh environment (radiation), extending considerably the application field of solid-state devices.

Source: IMEC