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Layer transfer technology for post-Si semiconductors

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Post-Si materials, such as III-V semiconductors or Ge, have been considered as alternative channel materials to Si, thanks to their higher intrinsic carrier mobilities. It is therefore necessary to form high quality Ge and III-V compound semiconductor layers onto large-scale Si wafers for the realization of Si and post-Si composite devices. Layer transfer technology using bonding techniques is a practical solution while the epitaxial growth of different materials on Si is extremely difficult. We show that high quality Ge and GaAs epitaxial thin films can be grown on lattice-matched GaAs single crystal substrates using MOCVD technology. In the case of semiconductor-on-Insulator wafer fabrication processes, an Al_2O_3 insulator is initially deposited on the epitaxial thin film by atomic layer deposition (ALD). In conjunction with low-temperature bonding and patterned Epitaxial Lift-Off (ELO) techniques, we achieved high quality Ge or III-V layer transfer on the full-wafer scale. The thin epitaxial film can be chemically lifted-off by selectively removing a sacrificial epitaxial layer grown between the epitaxial film and the substrate. We characterized the crystalline quality of transferred GaAs and Ge layers following the wafer-bonding and wet ELO processes, and find no significant difference compared with the as-grown epitaxial layers. To enlarge the transferred area, Ge layer transfers with multiple chip-to-wafer bonding and thin epitaxial film transfer onto 300 mm Si wafers were demonstrated for large-scale production. Low temperature layer transfer technology using the ELO technique provides a flexible opportunity to elaborate upon Ge and III-V based substrates for post silicon CMOS as well as for monolithic heterogeneous integration in a cost effective manner.

Keywords: Post-Si materials, layer transfer, Epitaxial Lift-Off (maximum 5 key words)

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