A Unique Method of Forming Pseudomorphic and Relaxed GeSi:Si Heterostructures on Silicon-on-Insulator

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While the performance of Si-based integrated circuits has benefited greatly from the continual decrease in feature size of devices, future gains are anticipated through the integration of more "functional" materials on the Si platform. In particular, Si:Ge_xSi_{1-x} (x = 0.1–0.2) heterostructures have been shown to exhibit greatly increased carrier mobilities within pseudomorphic layers allowing for much faster device operation. However, integration of Ge_xSi_{1-x} films onto a Si platform requires the formation of a virtual substrate able to accommodate the wide range of lattice parameters associated with the different film compositions. A method of forming Ge_xSi_{1-x} films on Si will be discussed that involves oxidation of a Ge-implanted Si wafer. Segregation of Ge during oxidation produces an enriched layer of Ge at the oxide interface that is oriented crystallographically with the underlying silicon. Processing conditions can be adjusted to produce a film of arbitrary composition and lattice parameter between Si and pure Ge. It will be shown that this involves not only different oxidation conditions but also the use of novel materials such as silicon-on-insulator (SOI). In the case of SOI, the buried oxide/Si interface will be shown useful in encapsulating the segregated film between the top and buried-oxide layers. This encapsulation decouples the film from the Si substrate and, thus removes this constraint on the film to relax. Characterization of the films formed by this method will be discussed as well as methods to achieve pseudomorphic and relaxed structures.

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