

Optical and Structural Properties of Group-IV Oxides Produced by Rapid Thermal Annealing

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This project investigates the rapid thermal oxidation of Ge(Sn) on Si by examining their optical and structural changes. Group-IV oxides, particularly GeO₂, are promising piezoelectric materials suitable at high-temperature environments. As-received samples, prepared by chemical vapor deposition, underwent ultrasonic cleaning before oxidation. The samples were rapidly thermally oxidized at a pressure of 2.7 atm with an oxygen flow rate of about 0.2 L/min. Spectroscopic ellipsometry measurements revealed that oxide thickness increased with both annealing temperature and time. Depolarization and surface discoloration indicated non-uniformity within the oxide, which was incorporated into their optical modeling. X-ray diffraction confirmed formation of α -GeO₂. Reciprocal space maps were used to determine the strain state of the Ge epilayer and the relaxation/Sn content for the GeSn epilayer. The Deal-Grove model described Ge oxidation on Si, resulting in an activation energy of 4 ± 2 eV for oxygen diffusion in Ge. The oxidation consumption rates for Ge and GeSn epilayers were determined to be 0.56-0.57 and 0.54, respectively.

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