Electrical & Computer Engineering

S E M I N A R

Louisiana State University

Optical and Electronic Transport Properties of Si Nanostructures

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Abstract—A detailed investigation focused upon evaluating the effects dimensional nanoscaling of silicon features on the optical and electronic properties is presented. The feature dimensions in this study ranged from ≈200nm down to ≈10nm. This range represents the transition region from material bulk properties towards the onset of quantization. These structures were fabricated on silicon-on-insulator using interferometric lithography, reactive-ion-etching and thermal oxidation methods. In order to investigate the optical and electronic properties, the nanostructures were configured in a two terminal metal-semiconductor-metal test device arrangement. The metal-semiconductor-metal configuration was chosen for this study due to its practicality in photonic and electronic parameter characterization and the ease of device fabrication. Characterization methods included steady-state DC measurements and transient time response measurements using a modified version of the Haynes-Shockley experiment for evaluating the carrier mobility as a function of feature size. Results show that the total carrier drift-diffusion dependent conduction for same biasing conditions increased as the feature dimension was reduced from ≈200nm to ≈10nm. The transient time response measurements show that the low field electron mobility can be increased in the best case at room temperature from ≈1000 cm^2/V-s to ≈4000 cm^2/V-s as the cross-sectional area becomes narrower due to confinement effects. Theoretical models for optical coupling and electronic transport properties are provided to give physical insight at these small scales.

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