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Shear-Induced Phase Transformation: From Single-Crystal Silicon to Si-IV GUOSONG ZENG, Center for Photonics and Nanoelectronics, Department of Mechanical Engineering and Mechanics, Lehigh University, BRANDON KRICK, Department of Mechanical Engineering and Mechanics, Lehigh University, NELSON TANSU, Center for Photonics and Nanoelectronics, Department of Electrical and Computer Engineering, Lehigh University — Silicon has been recognized as one of the most important semiconductors in modern electronics industry. Investigations in the past decades have led to observation of more than 12 different polymorphs of silicon. Among these polymorphs, the wurtzite silicon (Si-IV) shows promising application potential. It has been widely accepted that Si-IV is a metastable phase of silicon forming from annealing Si-III at temperature range between 200 C and 600 C. Besides the annealing, the shear stress can also lead to the phase transition from Si-I into Si-IV. It has been confirmed that the mechanism of shear-induced phase transition is different from that observed from hydrostatic pressure-induced phase transition. However, this shear-induced phase transition has not been studied systematically, and further investigations are required to clarify this transition on silicon. In this work, we develop a new method to study the formation of Si-IV. Combining nanoscratching and micro-Raman spectroscopy, shear effect on Si-I to Si-IV phase transformation has been studied qualitatively and quantitatively. A clear evolution of phase transition of silicon has been recorded. The stability of Si-IV has been analyzed by applying an in-situ Raman measurement under various temperature.

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