Poster Presentation

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Temperature-dependent mechanical deformation of silicon at the nanoscale

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High-temperature nanoindentation coupled with in-situ electrical measurements has been used to investigate the temperature dependence (25–200oC) of the phase transformation behavior of diamond cubic (dc) silicon at the nanoscale.1 Along with in-situ indentation and electrical data, Raman and cross-sectional transmission electron microscopy have also been used to reveal the indentation-induced deformation mechanisms in crystalline Si wafer. This study finds that phase transformation and defect propagation within the crystal lattice are not mutually exclusive deformation processes at elevated temperature. Depending on the temperature and loading conditions both the deformation mechanisms can occur up to 150oC but to different extents. It is observed that phase transformation is dominant below 100oC but deformation by twinning along {111} planes dominates at 150oC and 200oC. This work, therefore, provides clear insight into the temperature dependent deformation mechanisms in dc-Si at the nanoscale and helps to clarify previous inconsistencies in the literature.1

1M. S. R. N. Kiran, T. T. Tran, L. A. Smillie, B. Haberl, D. Subianto, J. S. Williams, and J. E. Bradby, Journal of Applied Physics 117, 205901 (2015); doi: 10.1063/1.4921534

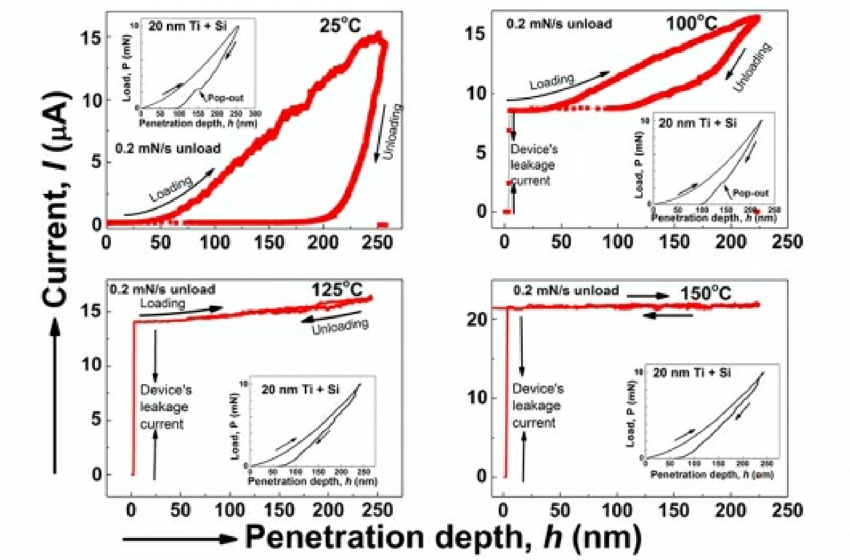

Fig: Current–depth curves from the device structure at a load of 10mN (under slow unloading conditions) at various temperatures up to 150ºC. The insets show the corresponding P-h curves obtained during indentation.1

Keywords: Nanoindentation, Phase transformation, Mechanical Properties