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High-resolution transmission electron microscopy analysis of bulk nanograined silicon processed by high-pressure torsion

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We report on high-resolution transmission electron microscopy observations of bulk nanograined silicon processed by severe plastic deformation through high-pressure torsion (HPT). Single crystalline Si(100) was subjected to HPT processing under a nominal pressure of 24 GPa at room temperature. The HPT-processed samples contained lattice defects such as dislocations and nanotwins in diamond-cubic Si-I, and metastable phases such as body-centered-cubic Si-III and hexagonal-diamond Si-IV. The grain size ranged from several nanometers up to several tens of nanometers. Subsequent annealing at 873 K led to the phase transformation to Si-I. No appreciable grain coarsening occurred after annealing while dislocations and nanotwins remained in the Si-I nanograins. The Si-I nanograin structure was retained even after annealing for 12 h.

Keywords: severe plastic deformation, high-pressure torsion, HRTEM, phase transformation, metastable phase, lattice defects

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