Department of Materials Science and Engineering,

Candidacy Exam

Date & Time

Wednesday, May 6, 2020 & 1:00 PM

Where

Zoom (https://drexel.zoom.us/j/93274997844)

Title

Deformation of graphite

Name:

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Abstract

Graphite is a technologically important material that has been intensely studied over the past century. The usual structure of graphite is hexagonal with a stacking sequence of ABABAB. The properties of graphite are quite anisotropic because of the very strong covalent bonds within the basal planes, and the weak Van der Waals forces between them. For instance, the elastic constant along the basal planes (c_{11}) recorded 1060 GPa. In contrast, at 36.5, GPa, the stiffness along the c-axis (c_{33}) is significantly lower. The shear modulus between layers (c_{44}) is the lowest component at 4 GPa. The basal plane has been identified as the shear plane where the critical resolved shear stress is exceedingly low. Stress-strain curves, derived by nanoindentation loading along c-axis, outlined the following: i) initial linear elastic behavior with slope of 36.5 GPa, ii) followed by a deviation from linearity at critical stress of ≈ 0.4 GPa, iii) followed by fully reversible, reproducible, dissipative, and closed hysteresis loops. Large (> 60 µm) pop-in events were observed at stress of ≈ 1.1 GPa. Delamination voids of various types, cleavage cracks, double twin band formation, kinking, lenticular opening and tilting, have been observed. These defect structures originate during crystal growth and subsequent compression and/or shear stresses. In other respects, radiation damage of graphite has been long investigated because it is use in nuclear fission reactors. Energetic particle bombardment results in swelling along the c-axis and corresponding shrinkage of the basal planes. That was explained by basal planes fragmentation, slipping, and bending as observed by transmission electron microscopy and confirmed by their respective selected area diffraction patterns. The dislocations and ripplocation models that have been developed to explain deformation in graphite will be reviewed.