Ion Implantation Effects on CVD SiC and Carbon-Carbon Velvet

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Materials Irradiation Experiments and the UW-Madison IEC Device

Summary of Presented Experiments

- SRIM calculations have been used to estimate the range of He⁺ in CVD silicon carbide (SiC) as well as the range of He⁺ and D⁺ in carbon-carbon velvet (CCV) and tungsten coated carbon-carbon velvet (CCV/W).
- CVD SiC samples (supplied by ORNL) were irradiated in the UW IEC device to 1x10¹⁸ and 1x10¹⁹ He⁺/cm² at 850 and 950 °C.
  - A partially masked SiC sample was irradiated to ~1.5x10¹⁸ He⁺/cm² at 950 °C
  - CCV and CCV/W samples were irradiated to 1x10¹⁹ He⁺/cm² at 1150°C and a CCV sample was irradiated to 1x10²⁰ D⁺/cm²
- SEM analysis has been performed to evaluate the surface damage on the CVD SiC, CCV, and CCV/W as functions of temperature and/or fluence.

SRIM Range Calculations and Sample Setup

- To the left, ion ranges in CVD SiC, CCV, and CCV/W are shown as a function of the IEC ion energy. Investigated implantation energies are noted.
- Helium ion range in the CVD SiC corresponds roughly to the flake thickness resultant from irradiation (a few microns).
- None of the calculated ion ranges correspond to the damage penetration depth observed in the velvet specimens.

SiC Conclusions

- Significant changes in SiC surface morphology occur at both 850 and 950 °C and fluences (1x10¹⁸ He⁺/cm² to 1x10¹⁹ He⁺/cm²)
  - At constant He⁺ fluence, the characteristic damage of the sample is a function of the temperature at which the sample is irradiated
  - However, ion fluence - NOT temperature, causes these surface morphology changes

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CCV and CCV/W Conclusions

- Both He⁺ and D⁺ irradiation of carbon-carbon velvet specimens cause fiber shaft corrugation, though He⁺ irradiated samples have a more pronounced effect.
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- Some W-coated carbon fiber shafts incur rupturing, in addition to increased W surface roughness after He⁺ irradiation.