



# Ion Implantation Effects on CVD SiC and Carbon-Carbon Velvet



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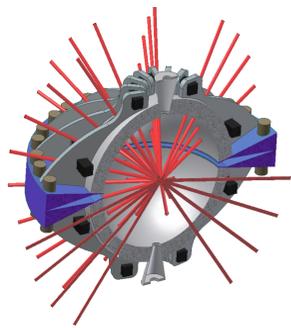
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## Carbon-Carbon Velvet Irradiation Experiments for the First Wall of the HAPL Reactor

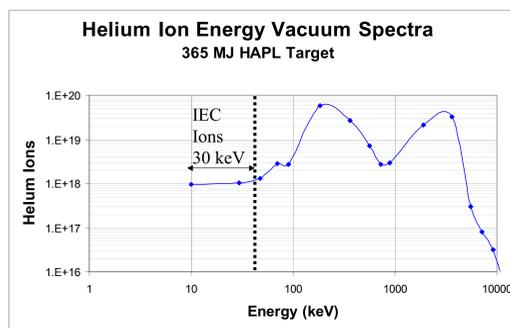
### Summary of Presented Experiments

- SRIM calculations have been used to estimate the range of He<sup>+</sup> and D<sup>+</sup> in carbon-carbon velvet (CCV) and the range of He<sup>+</sup> tungsten coated carbon-carbon velvet (CCV/W).
- CCV and CCV/W samples were irradiated to 1x10<sup>19</sup> He<sup>+</sup>/cm<sup>2</sup> at 1150°C and a CCV sample was irradiated to 1x10<sup>19</sup> D<sup>+</sup>/cm<sup>2</sup>
- SEM analysis has been performed to evaluate the surface damage on the CCV and CCV/W as functions of temperature and/or fluence.

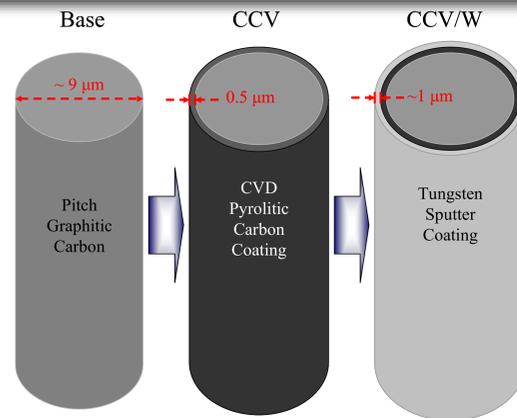
Objective: Investigate the damage effects of helium and deuterium implantation on the first wall armor of the High Average Pulsed Laser (HAPL) reactor



Cutaway Schematic of HAPL Chamber



## Ion Range & Carbon-Carbon Velvet Composition

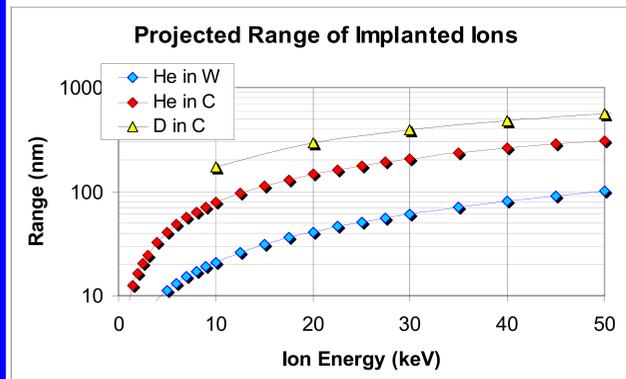


• Velvet fibers are ~1 mm long by ~10 μm diameter. CCV specimens use pitch graphitic carbon as the base material of the fiber (~9 μm diameter) and are then CVD coated by an amorphous carbon layer (~0.5 μm).

• CCV/W samples receive an additional sputter coating of tungsten ~1 μm thickness.

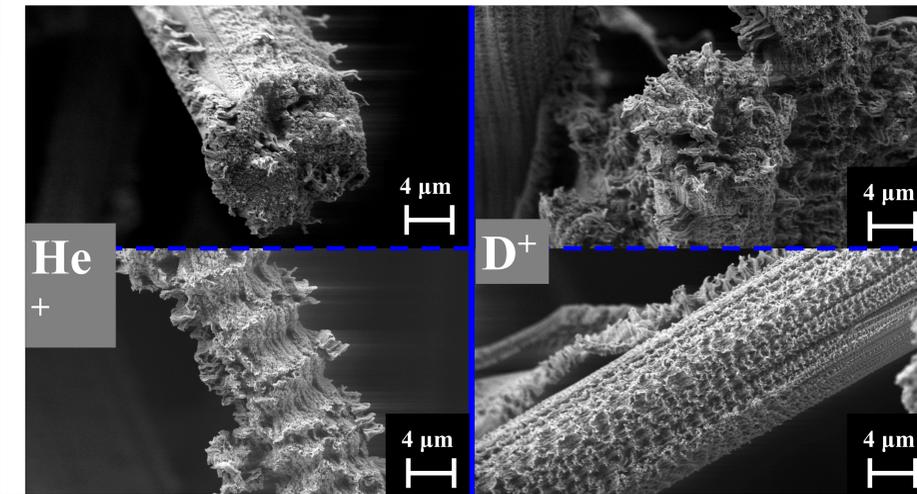
• To the left, He<sup>+</sup> and D<sup>+</sup> ranges in CCV, and CCV/W are shown as a function of the IEC ion energy.

• None of the calculated ion ranges correspond to the damage penetration depth observed in the velvet specimens.

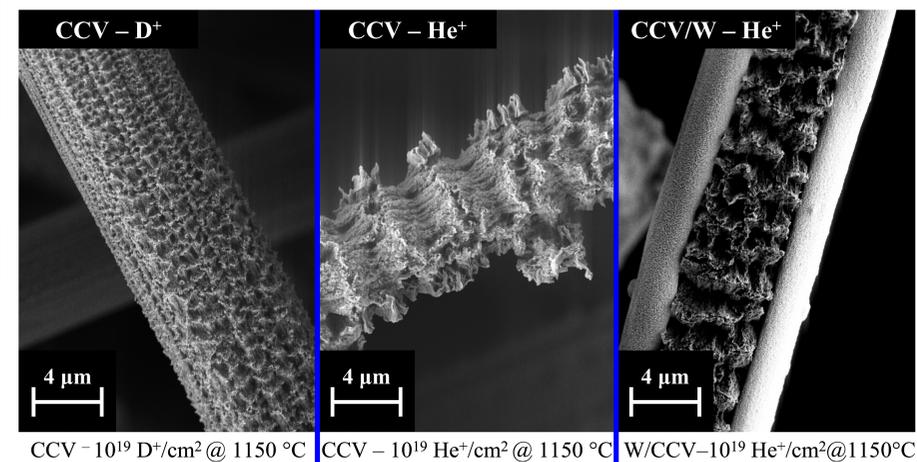


## He<sup>+</sup> and D<sup>+</sup> Irradiation of CCV and CCV/W

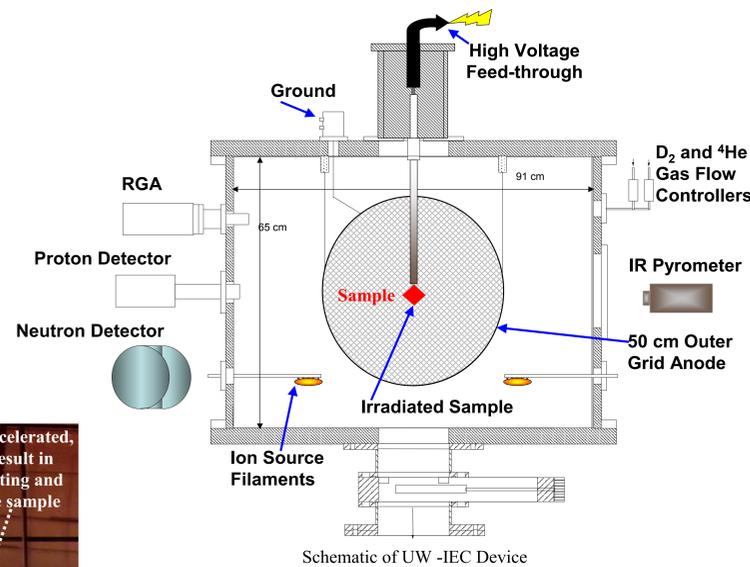
• CCV irradiated with He<sup>+</sup> and D<sup>+</sup> to a fluence of 1x10<sup>19</sup> ions/cm<sup>2</sup> at ~1150 °C



• CCV irradiated with He<sup>+</sup> and D<sup>+</sup> and CCV/W irradiated with He<sup>+</sup> to fluences of 1x10<sup>19</sup> ions/cm<sup>2</sup> at ~1150 °C



## IEC Setup for Materials Irradiation



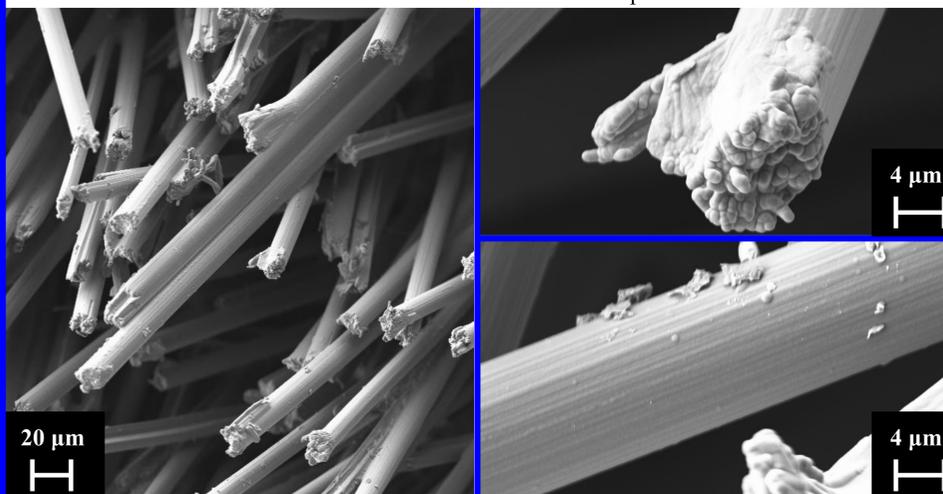
• He<sup>+</sup> and D<sup>+</sup> are accelerated, bombard, and result in simultaneous heating and irradiation of the sample



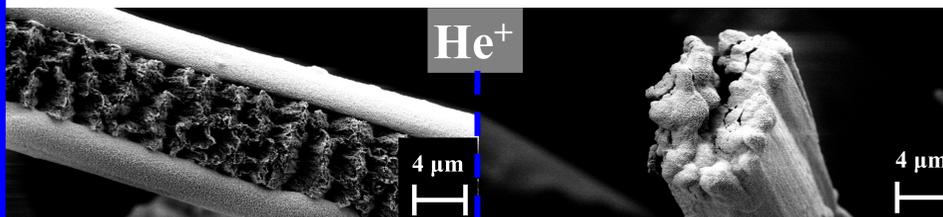
CCV

## He<sup>+</sup> and D<sup>+</sup> Irradiation of CCV and CCV/W

• Unirradiated Carbon-Carbon Velvet Specimen



• Tungsten-coated carbon-carbon velvet (CCV/W) irradiated with He<sup>+</sup> to a fluence of 1x10<sup>19</sup> ions/cm<sup>2</sup> at ~1150 °C



## CCV and CCV/W Conclusions

- Both He<sup>+</sup> and D<sup>+</sup> irradiation of carbon-carbon velvet specimens cause fiber shaft corrugation, though He<sup>+</sup> irradiated samples have a more pronounced effect.
- Both He<sup>+</sup> and D<sup>+</sup> irradiation of carbon-carbon velvet specimens causes fiber shaft corrugation, though He<sup>+</sup> irradiated samples have a more pronounced effect
- Some W-coated carbon fiber shafts incur rupturing, in addition to increased W surface roughness after He<sup>+</sup> irradiation
- Each sample experiences measurable mass loss after irradiation

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• For materials irradiation experiments the inner cathode grid is replaced with the carbon velvet specimens