# Dendritic Engineered Refractory Armor for Fusion Energy Applications

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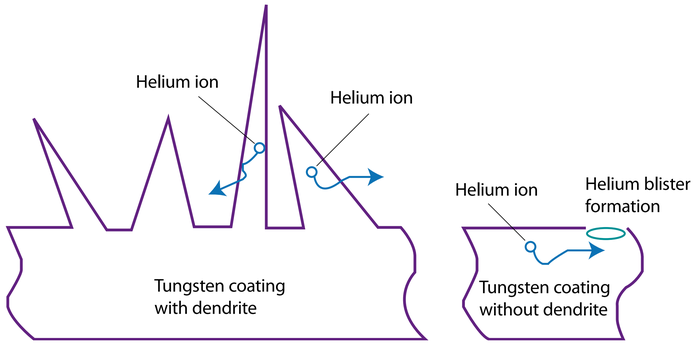
Phase I SBIR for DOE (contract DE-SC000149)

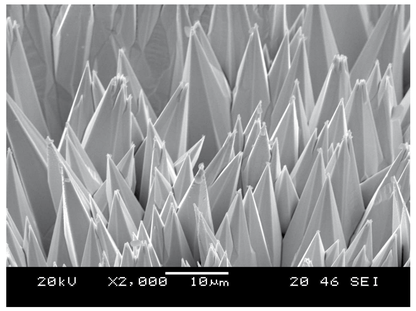
## Goal

To develop a robust coating to prevent the blistering that occurs in tungsten plasma facing components as a result of the interaction of tungsten with helium and hydrogen isotopes.

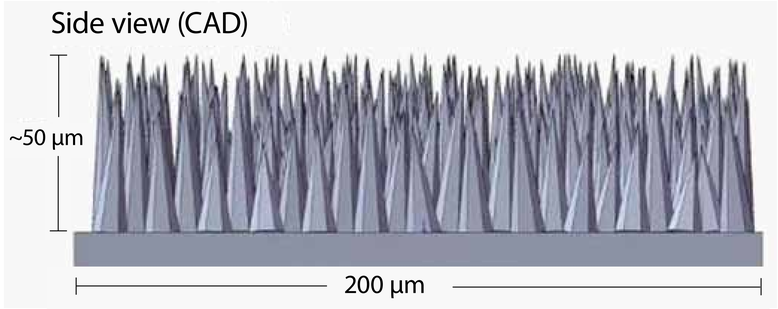
## Approach

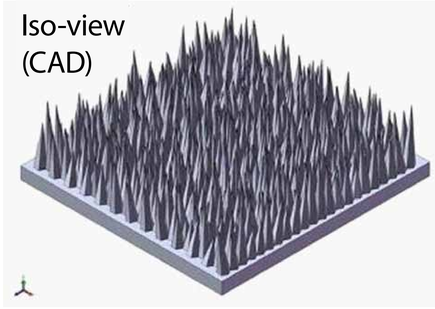
- Thermomechanical modeling of the CVD textured coating diverter armor was performed to determine optimal dendrite geometry.
- The helium recycling efficiency of the dendritic surface and near-surface implanted helium transport were modeled.
- Initial CVD processing conditions were established for fabrication of coated development specimens that were subjected to ion beam testing at Sandia. Coating materials were tungsten, molybdenum, rhenium, and layered combinations of the metals.
- Sandia evaluated response of the dendritic coatings to intense ion beams through testing in the RHEPP-1 ion beam facility.



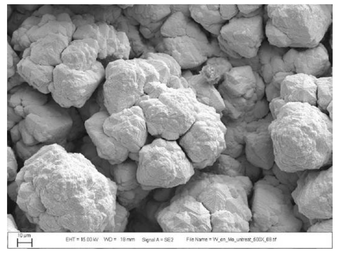




Dendritic or other textured coatings may be vapor deposited on surface of tungsten PFC structures to minimize helium entrapment and surface damage.

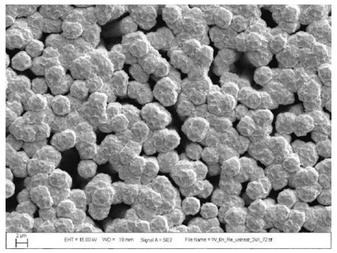


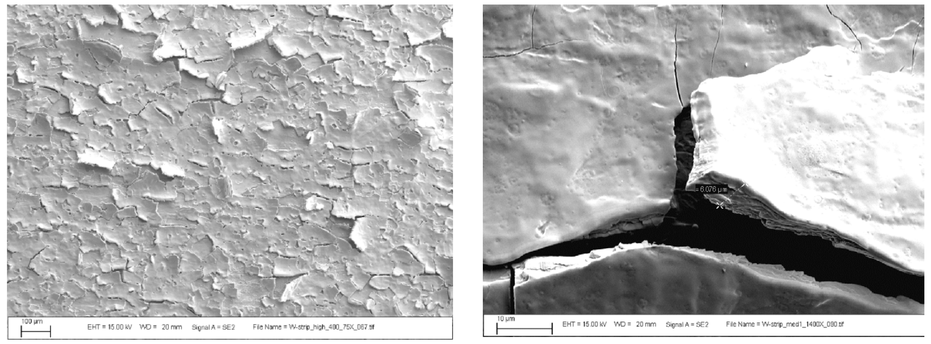

Solid models of needle-like dendrite structures generated for design and analysis



Coarse CVD tungsten nodular coating that survived 400 shots at a maximum fluence of 2.0 J/cm$^2$ with minimal surface damage



Heavy CVD tungsten deposited over high-density CVD rhenium dendrite coating that survived 400 shots at maximum fluence of 1.4 J/cm$^2$ with minimal surface damage.



Surface damage in powder metallurgy tungsten after 400 shots at 1.4 J/cm$^2$

## Summary

Design and analysis predicted that the three challenges of high heat loads, helium recycling, and net sputtering can be minimized by surface deposition of high purity tungsten in the form of dendrites or other textured shapes. The prediction for the first two challenges was supported by Phase I work in which coatings were deposited and then tested at the Sandia RHEPP-1 helium ion beam facility. Two coatings exhibited survivability that was far superior to alternative tungsten materials fabricated by powder processing.