Stress and Yield Modeling in BUCKY

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Bucky Simulations Have Been Performed for RHEPP Experiments on Pure Tungsten at Different Initial Temperature and Ion Types

1. Melt threshold fluence and peak surface temperature depend on initial temperature and ion type (He or N).
2. Stress calculations performed for selected cases. All samples should exhibit yielding.

Stress and Yield Post-Processing in Bucky

Thermo-Mechanical Tungsten Data From ITER
Materials Properties Handbook For BPTEC

Melting Threshold Fluence is Sensitive to Ion Type and Initial Temperature

• Predicted RHEPP melting fluences vary between 1.9 and 2.6 J/cm².
• Time Tamaki’s thermal properties used for W.
• Pre-shot heating of the sample lowers melt threshold.
• A higher He fluence is required to melt W.

Least Damaged Case Still has Yielded Material

At peak surface temperature, 2.5 μm of material is yielding

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Peak Surface Temperature is Sensitive to Ion Type

• Predicted RHEPP Peak surface temperatures show change in slope at melting.
• Pre-shot heating of the sample is not just an additive effect because of temperature dependence of properties.
• Higher surface temperatures are seen for N irradiation.

Melted Case Sees Substantial Yielded Material

When temperature goes beyond melting, stress model and data are invalid and “stress” values are meaningless.

The Mie-Grueneisen EOS Captures Important Solid State Physics


In a 6 parameter thermodynamically consistent EOS can be adjusted to capture tensile yield strength.

\[ \sigma_y = \frac{3\epsilon^2}{1 + \gamma} \]

And normal density, specific heat, and speed of sound.

In the Future, We Want to Try the Mie-Grueneisen EOS inside BUCKY to Model RHEPP and Z Experiments

1. M-G EOS in BUCKY will predict plastic flow with thermal and shock effects.
2. High strain rate and grain effects are probably playing some role in the roughening (grain size effect seen experimentally on RHEPP).
3. M-G EOS could be adapted to include grain and strain rate effects on yield stress and cohesive energy.
4. Once we are happy with Z and RHEPP modeling, apply M-G EOS to chamber wall simulations.