IFE Materials Response

Z Machine Materials Studies

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Outline

• Z machine
• Debris Issues
• Multipurpose radiation box (MPR)
• Methods of analysis
• Samples exposed and analyzed
  – W
  – Poco graphite
  – LiF
  – Honeycomb collimator
• Future Work
Z Machine

• Capabilities
  – 65 J/cm² of X rays in 20 ns
    (in present location)
  – Black body Temp.
    ~(200 eV)
• Availability
  – 1 shot per day
  – Piggy back mode
• Limitations
  – Only on shots when allowed
  – Depends on space available
  – Z machine needs to be in right configuration
  – Debris from target area must be mitigated
Debris Issues

• Z machine generates many X rays, but also debris from molten target material
• Fast valves may be an option, but only on occasional shots
• The MPRS box has significantly reduced the debris, but cannot eliminate it.

No collimation-20 µm debris

With collimation-1 µm
Multipurpose Radiation Box (MPR)

- Stainless steel box
- Inner slide with filter and additional apertures
- Collimation
Methods of analysis

• Surface Profiling
  – Mechanical-Dektak
  – Optical-WYKO

• Scanning Electron Microscopy
  – Flat and cross sectioned samples
  – Measure debris depth of cross section samples
  – Elemental analysis

• Time-of-Flight Mass Spectroscopy
  – Depth profiling of debris
### Proposed and tested samples on Z

<table>
<thead>
<tr>
<th>Material</th>
<th>Fluence</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphite (Poco)</td>
<td>7 J/cm²</td>
<td>Dry wall</td>
</tr>
<tr>
<td>Tungsten</td>
<td>~ 7 J/cm²</td>
<td>Dry wall</td>
</tr>
<tr>
<td>LiF</td>
<td>42 J/cm²</td>
<td>Wetted wall surrogate</td>
</tr>
<tr>
<td>Carbon velvet</td>
<td>~ 42 J/cm²</td>
<td>Dry wall</td>
</tr>
<tr>
<td>Silicon Carbide</td>
<td></td>
<td>Dry wall</td>
</tr>
<tr>
<td>Carbon Composite</td>
<td></td>
<td>Dry Wall</td>
</tr>
<tr>
<td>Silicon wafer</td>
<td></td>
<td>Reference material</td>
</tr>
<tr>
<td>Aluminum</td>
<td></td>
<td>Reference material</td>
</tr>
<tr>
<td>FLiBe</td>
<td></td>
<td>Wetted wall</td>
</tr>
</tbody>
</table>

*Note: FLiBe is an acronym for Fluorine-Lithium-Beryllium.*
Tungsten

W sample shows pitting, but the surface level is approximately level. Filtered sample.
Poco Graphite

- Poco graphite, polished
  - Exposed in MPR box
  - 2 micron Kimfol + 100Å Al Filter
- Debris layer consists of Fe, Ni, Cu, Al
- No significant level change from ablation, instead 1-2 µm pits developed

SEM shows 1 µm debris
Lithium Fluoride as a FLiBe substitute

- LiF vacuum windows
  - Exposed in MPR box
  - No filters, only collimation
- Measured 3 micron step between original level and exposed region
- Flat ridge of LiF formed around edge of exposed region

Height profile
Carbon velvet and honeycomb collimator

- Honeycomb collimator of Celcor
  - 1mm openings, 25 mm long
  - Aspect ratio similar to MPR box
- Material tested both collimated and open exposures on Z
  - 2 densities of carbon velvet
  - Carbon mirror
  - Epoxy coated Al
- Results
  - Much more velvet left on sample behind collimator
  - Little debris behind collimator
  - Honeycomb pattern on all samples behind collimator
Future Work

- Adjust flux levels to determine threshold levels
- Test more materials
- How best to analyze carbon velvet and carbon composite materials?
- Fielding molten samples
- Start up web site