Long-Term Storage of Tritium in Titanium

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Background

- Titanium is stable readily available material
  - High storage capacity
  - Cost-effective
  - Stable in air
  - Good helium retention
- Available mostly as powder and sponge
- Requires activation at high temperatures ~600 °C
- Presents a complex phase diagram
- Formation of $^3$He due to tritium decay
  - May affect absorption/desorption properties
  - May cause tritium trapped in the lattice
- The $^3$He is retained in the matrix until an accelerated release point
  - Literature indicates to be between 0.23-0.30 $^3$He/Ti at room temperature
Background

- Program started to support development of tritium thermal generator (TTG)
  - Titanium reduces SS-tritium compatibility issues
  - $^{3}$He will be mostly retained in the hydride matrix
- SRNL-Sandia collaboration

45.6 g HCRH Ti-foil
(D+T)/Ti=1.90
1.17 g tritium

3003 Al tube
Mott grade-20
316SS frit

Titanium foil stack for TTG
Background

• Pd-coated Titanium foil does not require activation
• Film thickness ~180 nm
• Available commercially as getter
• Mechanism not completely understood
  – Increase in rate of absorption and dissociation
  – Low desorption energy might cause a more evenly distribution of hydrogen in titanium
• Relatively little work on Pd-coated titanium and long term temperature effect
Main Task: Monitoring $^3$He release by measuring pressure from the sample bottles.

<table>
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<th>-60°C</th>
<th>20°C</th>
<th>180°C</th>
<th>300°C</th>
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<tbody>
<tr>
<td>100% tritium</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>50% tritium</td>
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</tr>
<tr>
<td>0% tritium</td>
<td>2</td>
<td>2</td>
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Results

- Low pressures observed compared to predictions
- No correlation with storage temperature
- Accelerated release point occurs later than predicted
Summary

- Tritium-loaded samples are only starting to show significant $^3$He release.
- 24 samples completed on current FY
- Later than expected (~7 yr vs. 3-4 yr).

- Lower $^3$He releases than predicted
- Results suggest a more compact design for a TTG might be technically feasible.
Conclusions

• Results support the feasibility of a potential design of a TTG
• Cost-effective and efficient mode of storage of tritium
• More compact designs are possible based on $^3$He releases observed
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Questions & Comments