Preparation of Targets by Electrodeposition for Heavy Element Studies

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1. Target preparation technique
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   - Deposition cell

2. Stationary targets ↔ Rotating wheel targets

3. Application: chemical investigation of hassium (Z=108)
   - Target station at GSI
   - Target performance

4. Deposition conditions

5. Summary
1. Target preparation technique

**Molecular Plating (MP)**

- Deposition from organic media as a molecule (nitrate)
- Solvent: isopropanol
- Deposition time: 30-90 min
- Current density: mA/cm²
- Voltage: up to 1200 V
- Chemical purification prior to deposition possible

Deposition yield: up to 90%
Target thickness: mg/cm² possible
In order to avoid cross-contamination for each isotope a particular cell is used.

**Deposition cell for MP:**

- Small and simple set-up
- Components easy to replace
2. Stationary targets ↔ Rotating wheel targets

- Circular geometry
- Backing mounted into Al-frame after deposition

- Banana-shaped geometry
- Backing pre-mounted into Al-frame prior to deposition
2. Rotating wheel targets

Deposition cell for MP

- PEEK-funnel
- Banana-shaped volume, milled into PEEK-block
- Viton-seal
- Backing with Al-frame
- Ti-cathode block
2. Rotating wheel targets

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Backing</th>
<th>Thickness $[\mu g/cm^2]$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ba (nat)</td>
<td>Ti / 5(\mu m)</td>
<td>400</td>
</tr>
<tr>
<td>Ce (nat)</td>
<td>Ti / 5(\mu m)</td>
<td>800</td>
</tr>
<tr>
<td>Nd (nat)</td>
<td>Ti / 5(\mu m)</td>
<td>800</td>
</tr>
<tr>
<td>Gd(nat)</td>
<td>Be /10(\mu m)</td>
<td>1100</td>
</tr>
<tr>
<td>$^{152}$Gd</td>
<td>Be /10(\mu m)</td>
<td>800</td>
</tr>
<tr>
<td>Dy (nat)</td>
<td>Ti / 5(\mu m)</td>
<td>800</td>
</tr>
<tr>
<td>Er (nat)</td>
<td>Ti / 5(\mu m)</td>
<td>800</td>
</tr>
<tr>
<td>Yb (nat)</td>
<td>Ti / 6(\mu m)</td>
<td>300</td>
</tr>
<tr>
<td>U(nat)/Nd(nat)</td>
<td>Be /10(\mu m)</td>
<td>800</td>
</tr>
<tr>
<td>$^{248}$Cm</td>
<td>Be /15(\mu m)</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>Be /15(\mu m)</td>
<td>730</td>
</tr>
<tr>
<td></td>
<td>Be /15(\mu m)</td>
<td>690</td>
</tr>
<tr>
<td>$^{248}$Cm/$^{152}$Gd</td>
<td>Be /15(\mu m)</td>
<td>500</td>
</tr>
<tr>
<td>U(nat)</td>
<td>Be /15(\mu m)</td>
<td>800-1000</td>
</tr>
<tr>
<td>$^{232}$Th</td>
<td>Ti /5 (\mu m)</td>
<td>800-1000</td>
</tr>
</tbody>
</table>

Hs-chemistry experiment (GSI)

112-chemistry experiment (2003/2004 at GSI)

$^{232}$Th($^{12}$C,5n) planned at GSI
2. Target station “ARTESIA” at

- Target wheel drive
- Target wheel
- Beam collimator
- Beam
3. Application: Chemical investigation of Hs#  
#C. Düllmann et al., NATURE 418 (2002) 859

First chemical study of Hs (Z=108).  
10-s $^{269}$Hs produced via the $^{248}$Cm($^{26}$Mg,5n)-reaction.  
Isolation of volatile HsO$_4$ and subsequent detection of 7 $^{269}$Hs decay chains in a Si-detector array

- $^{26}$Mg$^{5+}$: 7.41 MeV/u / 50 Hz / 6 ms, pulsed  
- 1.0$\times10^{18}$ ions during a total of 64 h  
- Max. 6.6 eµA ($\approx$ 4.0 eµA average)  
- Stationary targets: max. 2.5 eµA
4. Deposition conditions

- Backing: Ti or Be (12-25 µm)
- 5-10 µl aqueous solution, dissolved in pre-cooled isopropanol
- Isopropanol temperature: 5-10 °C

**Lanthanide targets:**
- Voltage: 1200 V, constant
- Current: 0.2 - 3.0 mA
- Time: 90 minutes
- Yield: up to 90 %
- Thickness: 500-1100 µg/cm²

**U-, Cm-, Th-targets:**
- Voltage: 500-1200 V, stepwise
- Current: 0.05 - 3.4 mA
- Time: ≤ 90 min.
- Thickness: up to 1000 µg/cm² (U)
5. Summary

- Production of lanthanide and actinide targets by molecular plating
- Target thickness up to 1100 µg/cm²
- Higher beam currents with rotating wheel, compared to stationary target
- First chemical investigation of hassium, produced in the $^{248}\text{Cm}(^{26}\text{Mg},5n)$-reaction
- First chemical investigation of element 112 using the $^{238}\text{U}(^{48}\text{Ca},1/2n)$-reaction at GSI in 2003