Automation of a method for $^{124}$I production irradiating, Al$_2$Te$_3$ on 16-18 MeV cyclotrons; prospective for the production of other halogens

Paolo Bedeschi
R&D Manager,
COMECER - ITALY
The purposes of an automated system for Halogen Isotopes production are:

• to reduce the dose exposure of the operator during the whole process
• to have a high production rate
• to assure the process reproducibility
• to assure a good product quality in terms of chemical and isotopic purity
In order to achieve such targets the study has considered:

• development of a bi-directional pneumatic transfer system between the cyclotron and the dry distillation module

• development of a specific “Irradiation Module” for the automated target positioning with a high efficiency water and helium cooling system

• application of an industrial HF heating system on the distillation device

• study of a purification process using a disposable valve kit
TeO$_2$ → Al$_2$Te$_3$

<table>
<thead>
<tr>
<th>Step</th>
<th>TeO$_2$</th>
<th>Al$_2$Te$_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditioning</td>
<td>Green glassy solid (79% Te) &lt;0.1% loss</td>
<td>Black glassy solid (87% Te) &lt;0.2% loss</td>
</tr>
<tr>
<td>Irradiation</td>
<td>-27 mCi/µA &lt;1% loss @ 8 uA</td>
<td>31 mCi/µA &lt;1% loss @ 5 uA</td>
</tr>
<tr>
<td>Distillation</td>
<td>-65-80% from target &gt;90% plates to cooling quartz</td>
<td>-90-95% from target &gt;90% plating</td>
</tr>
</tbody>
</table>

**Desirable characteristics of a binary alloy M$_x^{124}$Te$_y$**

- Available or simple to make
- Low stopping power in M ⇒ low Z, small x
- Raises melting point, lowers vapor pressure ⇒ stable at high temperature in beam and distillation
- Thermal conductor
- Electrical conductor
- Releases iodine at reasonable temperature
ALCEO Solid Target System
Al₂Te₃ Solid Target

Aluminum and enriched Tellurium powders loading

High radio-frequency driven heating

2 Al + 3¹²⁴Te → Al₂¹²⁴Te₃

Al₂Te₃ Plating at 500 °C in less than 2 minutes

Glassy Solid Target ready for irradiation
Cooling System

Double cooling system with helium and water

Inlet/outlet water and helium temperature monitoring

Water flow control

Helium pressure control
Cooling System performance tests

Water flow: 4 l/min
$W = \frac{4 \times 4186}{60} = 280 \text{ W/°C}$
Cooling power: 1120 W

Helium flow: 15 Kg/min
(Expected) Cooling power: 100W
Iodine harvesting

High frequency inductive heating system

Iodine distillation through a bubbling system
SUSTAINABLE IODINE PRODUCTION

Iodine extracted from the target: 100%
Iodine harvested: 70% (with growing perspectives)
$\text{Al}_2\text{Te}_3$ Solid target re-usable for further bombardments
ALCEO, NOT A ONE TRICK PONY
PTS Module on PetTrace
PTS Module on Beam Line
... in case you need any technical support ...

You are welcome in Italy!

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Thanks for your kind attention