Cyclotron Production of I-123 by Bombardment of $^{124}\text{Te}$ Electroplated Target

Zhou Wei, Wang Yongxian, Yin Duanzhi

Shanghai Institute of Applied Physics,
Chinese Academy of Science
Nuclear process for production of $^{123}\text{I}$

- **Direct method:** (low energy cyclotron)
  - $^{121}\text{Sb}(\alpha,2n)^{123}\text{I}$,
  - $^{\text{nat}}\text{Sb}(^3\text{He},xn)^{123}\text{I}$,
  - $^{124}\text{Te}(p,2n)^{123}\text{I}$,
  - $^{123}\text{Te}(p, n)^{123}\text{I}$,
  - $^{122}\text{Te}(d,2n)^{123}\text{I}$ ...... 

- **Indirect method:** $^{123}\text{Xe} \rightarrow ^{123}\text{I}$
  (medium and high energy cyclotron)
  - $^{127}\text{I}(p, 5n)^{123}\text{Xe}$,
  - $^{124}\text{Xe}(p, 2n)^{123}\text{Xe}$
  - $^{124}\text{Xe}(p, pn)^{123}\text{Xe}$ ......
Te target for production of I-123

- Metal $^{124}$Te target
  - $2\pi$ or $4\pi$ cooling
  - wet chemical separation
- Molten $^{124}$TeO$_2$ target
  - $4\pi$ cooling
  - dry distillation
Source for $^{124}\text{TeO}_2$ lost

- Target heating to liberate $^{123}\text{I}$
  - loss of $^{124}\text{TeO}_2$: $<1\%$
- Accidental melting during irradiation
  - $2\pi$ cooling system
  - irradiation angle: 6 °
  - loss of $^{124}\text{TeO}_2$: 3~5%
Production method for electroplated target

- $^{124}$Te electroplated Target----molten target
- Irradiation
- Wet chemical separation -----dry distillation
- Recovery of the enriched tellurium
- Quality control
Targetry
Ni surface onto the Cu plate

- Ni plating solution:
  \[ \text{NiSO}_4 \cdot 6\text{H}_2\text{O} \]
  \[ \text{NiCl}_2 \cdot 6\text{H}_2\text{O} \]
  \[ \text{H}_3\text{BO}_3 \]
- pH: 3 ~ 4.
Targetry
Ni surface onto the Cu plate

- Current: 200mA
- Time: 12 min
- Anode: platinum electrode
- Cathode: Cu plate
- Current efficiency: 90%
- Ni thickness: 250ug/cm²
Targetry
Electroplating of enriched $^{124}\text{Te}$

- Stock solution
  - $^{124}\text{Te} \rightarrow ^{124}\text{TeO}_2$
  - KOH solution
  - pH: 10～11
Targetry
Electroplating of enriched $^{124}$Te

- Current: 100 mA
- Time: 60 min
- Thickness: 12 mg/cm$^2$
- Wash
- Dry
$^{124}\text{Te}$ electroplated target
Irradiation

- Cyclone 30 (IBA)
- Proton energy: 25 MeV
- Beam current intensity: 20~50 µA
- Time of irradiation: 0.5~3 hr
- $^{123}$I yield: 8.2 mCi/µA h
- $^{124}$Te loss: <1% each run
Separation of I-123 from tellunium

- Dissolution of $^{124}\text{Te}(\text{NaOH} + \text{H}_2\text{O}_2)$
- Aluminum power
- Heating gently
- Stream distillation
- Precipitation ($\text{Te}^0 + \text{Al(OH)}_3$)
- Filter
- Radiochemical yield: >90%
Recovery of the enriched Te-124

- Dissolution of power\((\text{Te}^0 + \text{Al(OH)}_3)\)
  \[ \text{H}_2\text{SO}_4 + \text{H}_2\text{O}_2 \]
- Distillation
- Hypophosphorus acid
- Precipitate of tellurium
- washed and dried
- $^{124}\text{Te}$ recovery : $>99.5\%$
Quality Control

- Radionuclidic purity
- Radioactivity concentration
- Radiochemical purity
- pH value
- Concentration of Al & Te
- Bacterial endotoxins
Result and discussion

- **Target**
  - thickness: Ni 250ug/cm², Te 12mg/cm²
- $^{123}$I yield: 8.2mCi/µA hr
- $^{124}$Te loss: 1% each run
- Radiochemical yield: >90%
- $^{124}$Te recovery: >99.5%
Influence of beam current intensity on loss of Te

Fig. 1 Relationship between loss of Te and beam current intensity
Influence of thickness of Ni layer on loss of Te

Fig. 2 Relationship between loss of Te and thickness of Ni layer

$^{124}\text{Te(p,2n)}^{123}\text{I}$

50μA, 1hr
Influence of thickness of Te on loss of Te

Fig. 3 Relationship between loss of Te and thickness of Te

$^{124}\text{Te}(p,2n)^{123}\text{I}$

50uA, 1hr

loss of Te (%) vs. thickness of Te (mg/cm$^2$)
Influence of thickness of Te on yield of $^{123}$I

Fig. 4 Influence of thickness of $^{124}$Te on yield of $^{123}$I
Influence of integrated current on yield of $^{123}\text{I}$

$^{124}\text{Te(p,2n)}^{123}\text{I}$

$^{124}\text{Te}$ target: 13mg/cm²

Fig. 5 Relationship between yield of $^{123}\text{I}$ and integrated current
Specification of $^{123}$I solution

- Radionuclidic purity: $>98\%$.
- Radiochemical purity: Iodide $^{123}$I $>95\%$
- Radioactivity concentration: $>3700$ MBq/mL.
- pH value: 7.5~9.0
- Concentration of Al: $<1\mu$g/mL
- Concentration of Te: $<1\mu$g/mL
- Bacterial endotoxins: $<30$EU/mL
Thank you for your attention!