

# Development of a Low-loss, Minimal Exposure Technique for Thallium Foil Fabrication

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# Outline

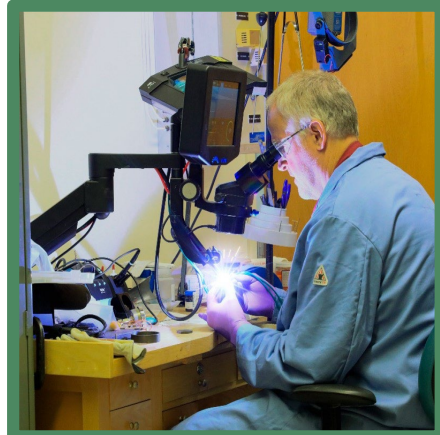
- Group Introduction
- Project Overview
- Health and Safety Concerns
- Low Loss Melt
- Cold roll
- Cutting and packaging
- Cleanup Procedures

# Stable Isotope Materials and Chemistry Group

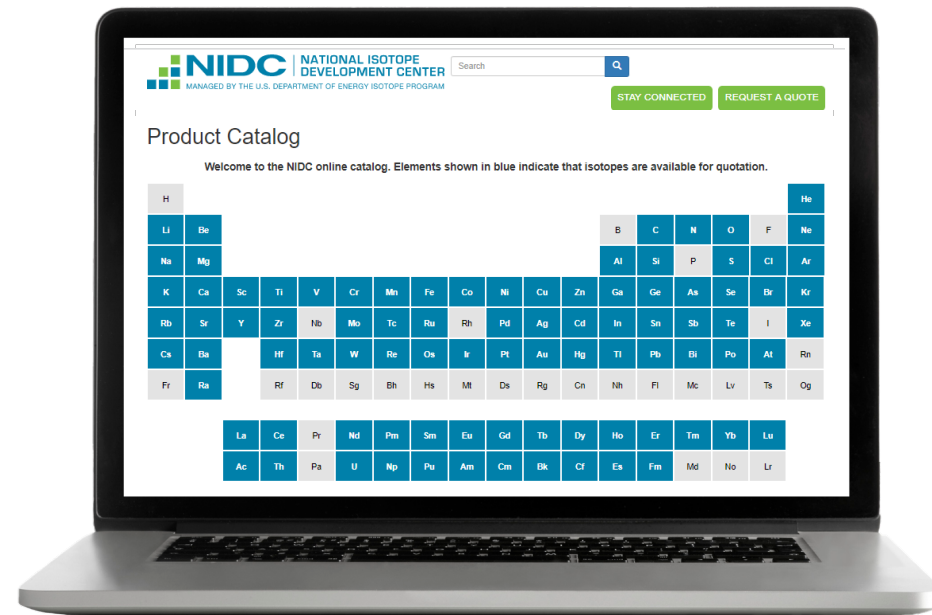
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# Project Development

Requested to complete fabrication of 40 foils of natural Thallium

- Not commercially available
- 2.5cm x 2.5cm x 50-75mg/cm<sup>2</sup>
- Decades of institutional knowledge and internal subject matter experts informed technique development
- Technique applied toward isotopic material in the future



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# Toxicity of Thallium Metal

	Thallium	Lead
8-hour Total Weight Average (TWA) of the Permissible Exposure Limit	0.02mg/m <sup>3</sup> (air)  0.1mg/m <sup>3</sup> (skin)	0.05mg/m <sup>3</sup> (air)
Major pathway	Inhalation, ingestion, skin contact	Inhalation
Lethal dose	10-15mg/kg	450-720mg/kg
Engineering Controls and Personal Protective Equipment	Nitrile gloves, Tychem suit, Powered Air Purifying Respirator, use chemical hood	Nitrile gloves, Tychem suit, use chemical hood
Additional Testing	NIOSH 7303 sampling (Respiratory)  Blood sampling  IOP 01-12.05 and EPA 6010C (surface contamination)	



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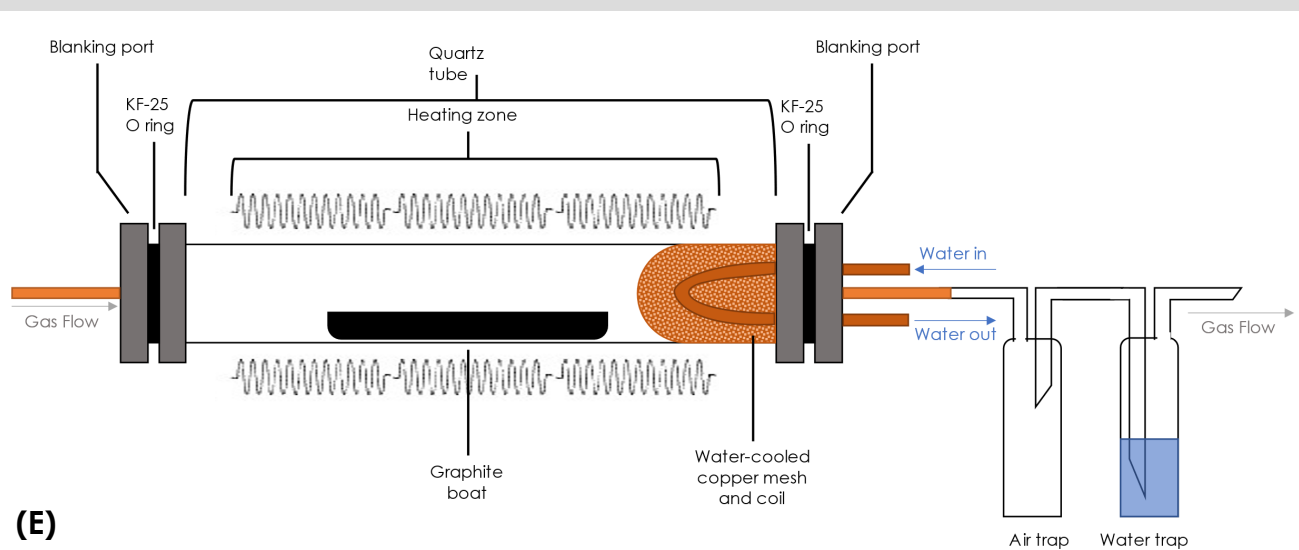
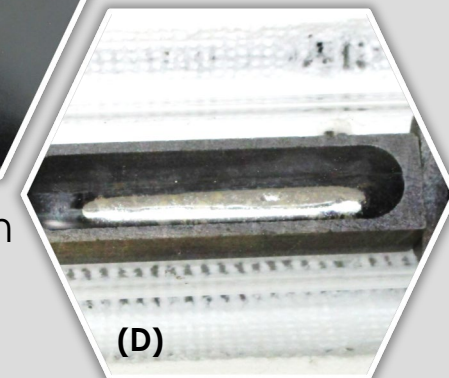
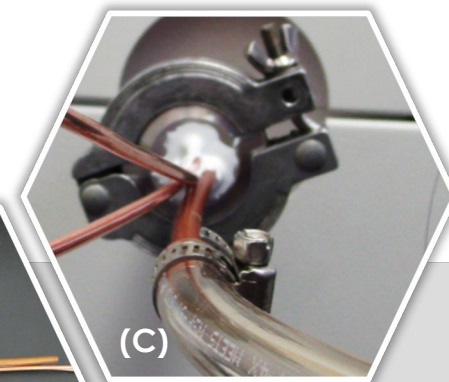
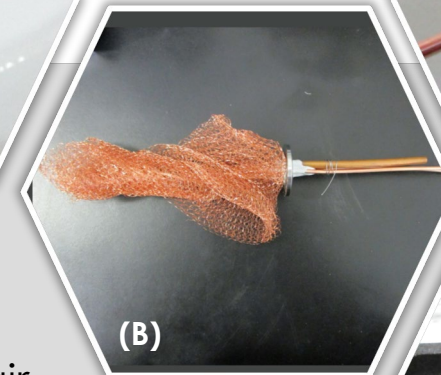
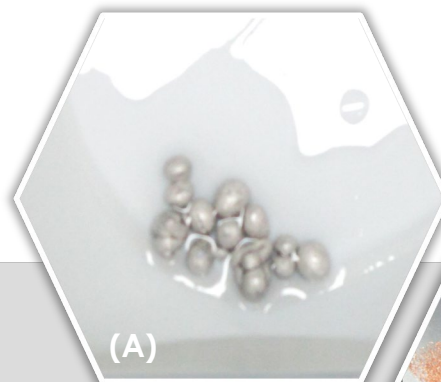
# Low Loss Melting Apparatus

## Challenge

Material must be heated above melting point (303°C) and cooled quickly to consolidate to a single ingot without significant vaporization

## Solution

- Developed a fully enclosed, single-use tube furnace with H<sub>2</sub> reduction capability
- Copper mesh capture system followed by air and water trap used to combat low temperature vaporization
- Graphite boat showed limited to no reaction with Thallium metal during melting



- (A) Thallium metal shot, as obtained from the material supplier  
 (B) Water cooled copper mesh and outlet  
 (C) Sealed outlet blanking port  
 (D) Thallium ingot after melting at 330°C, 5 mins  
 (E) Melting Apparatus Setup

# Cold Rolling Thallium Metal

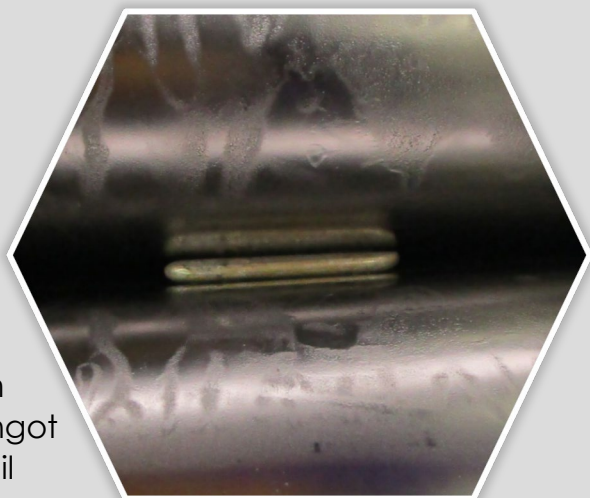
## Challenge

Thallium oxidizes readily in air

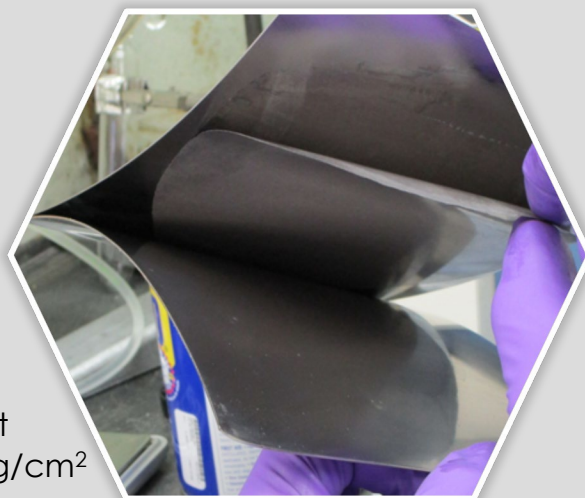
Thallium is extremely sticky and malleable

## Solution

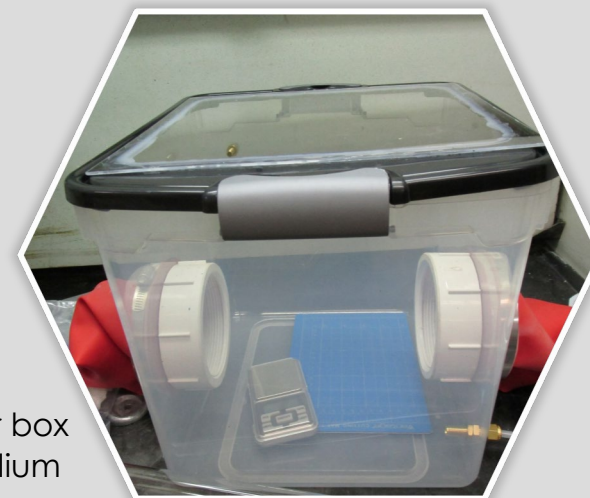
- Full PPE was used during handling
- Material was placed under oil to decrease oxidation during rolling
- When able, material was handled under an Argon blanket within a miniature glove box
- Completed rolling in a sacrificial stainless steel pack
- Ensured low force per unit area



Thallium metal ingot under oil



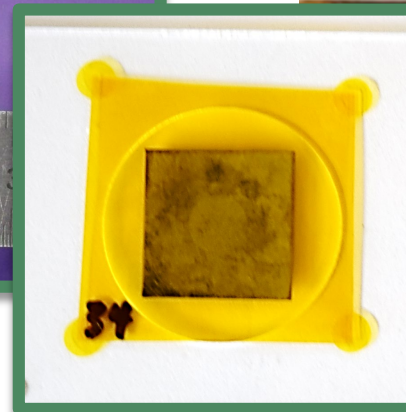
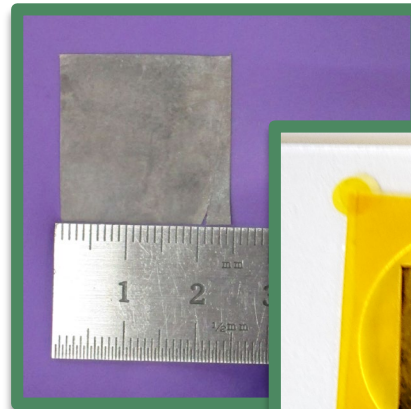
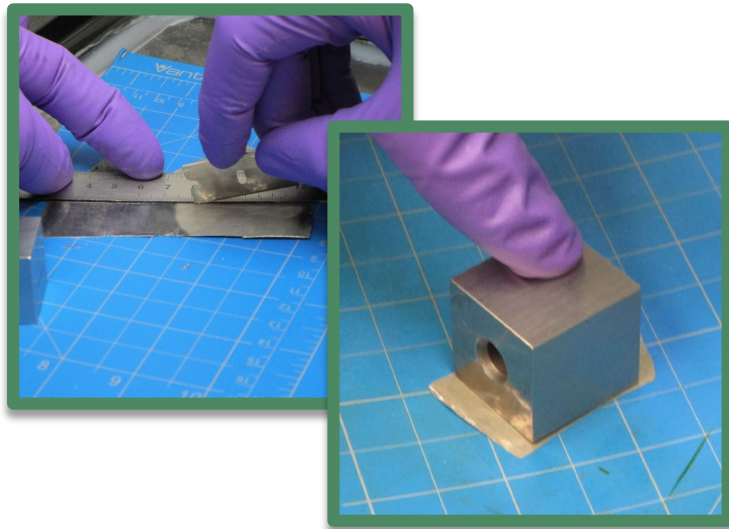
Thallium metal at 50-75mg/cm<sup>2</sup>



Inert air box for Thallium

# Cutting and Packaging Foils

- Thallium was cut into foils using a 2.50cm x 2.50cm template
- Foils were sealed in Kapton tape and secured to frames, per the customer's request





# Decontamination

- Respiratory and blood sampling resulted in numbers below the limit of detection
- Acceptable limit for allowable dosage by skin contact is  $200\mu\text{g}/100\text{cm}^2$ 
  - IOP 01-12.05, EPA 6010C
- Cleanup procedure
  - Formula 409 (Commercial Cleaner)
  - Scrubs Steel Cleaning and Conditioning Wipes
  - Ethanol

**We produced 40 thallium foils with high precision and well within safety parameters**

Area tested	Before decontamination ( $\mu\text{g}/\text{cm}^2$ )	After decontamination ( $\mu\text{g}/\text{cm}^2$ )
Chemical hood	27	<10
Rolling mill (top roll)	180	19
Rolling mill (bottom roll)	400	19



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**What are some of your trickiest targets?**



# Back Up Slides



# Contamination of Surfaces

## Before Decontamination

SAMP_NO	AGENT	RESULT	UNIT	Location of sample
SID14447-01	THALLIUM, SOLUBLE COMPOUNDS, AS TL	<10	UG/100CM2	Hood sash
SID14447-02	THALLIUM, SOLUBLE COMPOUNDS, AS TL	27	UG/100CM2	Working surface inside lab hood (beside small glovebox)
SID14447-03	THALLIUM, SOLUBLE COMPOUNDS, AS TL	<10	UG/100CM2	Right side wall inside lab hood
SID14447-04	THALLIUM, SOLUBLE COMPOUNDS, AS TL	14	UG/100CM2	Small glovebox in lab hood (top/handles)
SID14447-05	THALLIUM, SOLUBLE COMPOUNDS, AS TL	<10	UG/100CM2	Inside gloves of small glovebox
SID14447-06	THALLIUM, SOLUBLE COMPOUNDS, AS TL	<10	UG/100CM2	Lab floor (in front of lab hood)
SID14447-07	THALLIUM, SOLUBLE COMPOUNDS, AS TL	180	UG/100CM2	Press roller (top)
SID14447-08	THALLIUM, SOLUBLE COMPOUNDS, AS TL	400	UG/100CM2	Press roller (bottom)
SID14447-09	THALLIUM, SOLUBLE COMPOUNDS, AS TL	<10	UG/100CM2	Light gray chair (arms of chair)
SID14447-10	THALLIUM, SOLUBLE COMPOUNDS, AS TL	<10	UG/100CM2	Dar gray chair (arms of chair)
SID14447-11	THALLIUM, SOLUBLE COMPOUNDS, AS TL	<10	UG/100CM2	Field Blank
SID14447-12	THALLIUM, SOLUBLE COMPOUNDS, AS TL	<10	UG/100CM2	Field Blank

## After decontamination

Sample ID	Assessment Type	Description of Sample Equipment/Location	Sample Results (ug/100 cm2)
SID14499-01	Wipe Sampling	Working surface in lab hood IE-9575	<10
SID14499-02	Wipe Sampling	Working surface in lab hood IE-9575	<10
SID14499-03	Wipe Sampling	Sash of lab hood IE-9575	<10
SID14499-04	Wipe Sampling	Rt, back side bottom of furnace (around buttons)	<10
SID14499-05	Wipe Sampling	Front of furnace (around buttons)	<10
SID14499-06	Wipe Sampling	Top roller of Stanat 2 - high rolling mill	19
SID14499-07	Wipe Sampling	Bottom roller of Stanat 2 - high rolling mill	19
SID14499-08	Wipe Sampling	Buttons on east side of Stanat 2 - high rolling mill	<10
SID14499-09	Wipe Sampling	Wheel adjust on top of Stanat 2 - high rolling mill	<10
SID14499-10	Wipe Sampling	Counter beside lab hood IE-9575	<10
SID14499-11	Wipe Sampling	Field Blank	<10
SID14499-12	Wipe Sampling	Field Blank	<10