RECYCLING TITANIUM
The Role of the Titanium Scrap Processor

Orlando, Florida, USA   October 5, 2015
Company Overview – Goldman Titanium

• Goldman Titanium is a privately held, world-class processor of titanium scrap, including both solids and turnings.
• Titanium is our only business, making us experts in our field.
• As a pioneer in the titanium industry, our company was first established in 1955, and we have continuously expanded over the years.
• All of Goldman Titanium’s processes and titanium recycling operations conform to our ISO9001: 2008 Quality Management System as well as to AS9100:2009, Rev. C.
• Goldman Titanium purchases titanium scrap from suppliers in over 20 countries located around the globe.
• Our company’s products have been approved by major U.S., European, and Asian titanium melters.
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The Big Picture
Titanium Scrap and the Titanium Manufacturing Process

Consolidation
- Titanium Scrap
- Titanium Sponge
- Master Alloy

Melting
- Arc Melting
- Hearth Melting

Mill Processing
- Ingot → Mill Products

Titanium Scrap Processing
Where Does Titanium Scrap Come From?
Sources of Titanium Scrap
Where Does Titanium Scrap Go To?

Titanium Melting Furnaces

Source: http://blog.keytometals.com/
Where Does Titanium Scrap Go To?

Titanium Melting Specifications

Titanium melting specifications are driven by a number of factors, including furnace types, applications, scrap type (e.g., turnings, feedstock, weldables), and alloy.

Titanium melting specifications include but are not limited to the following:

- Sizing
- Chemistry
- Physical requirements
Titanium Scrap Processing
The Role of the Titanium Scrap Processor

1. To turn unprocessed Titanium Scrap into a finished product that meets titanium melters’ specifications

2. To hold excess inventory for melters

3. To have just-in-time, certified, furnace ready scrap readily available
Titanium Scrap Processing
The Role of the Titanium Scrap Processor

From Unprocessed Titanium Scrap ➔
To Processed Product That Meets Titanium Melters’ Specifications

Quality
Quality
Quality

ISO 9001:2008 Certified
Titanium Scrap Processing
Solids Processing

- **Sorting**
  - Alloy verification
  - Size
  - Physical Form/Quality

- **Sizing**
  - Crushing (cobbles)
  - Shearing
  - Torching

- **Cleaning**
  - Washing (cobbles)
  - Blasting & grinding

- **Final Inspection / Packaging**
  - Sampling
  - Inspection Belt
  - “Just-In-Time”

- **Certification**
  - Certifying that material meets customer specifications
Titanium Scrap Processing
Solids Processing: Sorting – Alloy Verification

Arc spark test units are used to 100% test every piece of metal when required and verify alloy
Titanium Scrap Processing
Solids Processing: Sorting - Sizing

6-4 solids are sorted into the following broad categories based on their ability to meet the sizing requirements below.

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<th>Category</th>
<th>Description</th>
<th>Photo (Finished Product)</th>
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| Crush      | Lighter/thinner solids (e.g., sheet, tube) that are crushed rather than sheared into cobbles.  
• Typically <.1 thick                                                  | ![Crush Product]          |
| Feedstock  | Small Solids – e.g., bar ends, flashings  
• >.1” thick  
• Each piece greater than ~.5 lb. and less than 5 lbs.  
• Can be sheared to 6” and down                                       | ![Feedstock Product]      |
| Weldables  | Heavier solids – e.g., forgings, plate, heavy flash, bar, billet  
• >.5” min thickness  
• 5 lb. min per piece                                                    | ![Weldables Product]      |
Titanium Scrap Processing
Solids Processing: Sorting – Physical Form/Quality

- Sorters must also inspect the physical form of each piece of metal to guarantee that is free from all contaminations and defects.

- Here is a list (not exhaustive) of some of the quality criteria that sorters must guarantee for 6-4 premium quality feedstock. Material must be free from:
  - Torch cut surfaces
  - Enfoliations
  - Cracks
  - Threaded holes
  - Incomplete/partial cuts
  - Castings
  - Fasteners
  - Bonded metals
  - Blind holes
  - Used parts
  - Gears
  - Welded metal

Incomplete Cut

Threaded Hole
Titanium Scrap Processing
Solids: Finished Product

Cobbles
Titanium Scrap Processing
Solids: Finished Product

Premium Grade Feedstock

[Images of titanium scrap processing materials]
Titanium Scrap Processing
Solids: Finished Product

Premium Grade Bulk Weldables

Plate
Rings
Forgings
Extrusions
Bar/Billet
Titanium Scrap Processing

Turnings Processing

- **Crushing**: Reduces size of turnings
- **Cleaning**: Removes oil & grease
- **Drying**: Removes moisture from clean turnings
- **Magnetizing**: Removes all magnetics
- **Screening**: Sizes clean turnings
- **Analyzing**: Ensures that the chemistry of the product complies with customer specifications
- **Briquetting**: Compacts turnings into hockey puck-like shaped product when desired
Titanium Scrap Processing

Turnings: Finished Product

Loose Turnings

Briquetted Turnings
Titanium Scrap Fire Safety & Prevention

Fire Prevention
- Good housekeeping
- Wet dust collector(s)
- Safe storage & handling
- Safety culture
- Company policies e.g. hot work, no smoking, vendors, etc.
- Corrective action procedures

Early Detection
- Proprietary systems

Risk Reduction
- Automatic suppression systems
- Employee training
- Fire extinguishers in working order
- Inventory control
- Communication with local fire department
Recent Titanium Scrap Pricing Trends

6-4 Titanium Scrap Processor Buying Prices - Past 12 Months*

*Trends are estimates provided by Goldman Titanium
QUESTIONS & ANSWERS