Presentation Outline

1. Advantages of using scrap.
2. The history of scrap titanium recycling.
3. Capturing a larger percentage of the titanium scrap stream.
4. The history of the scrap supply chain.
5. Summary
Corporate Structure

Cronimet GmbH

Cronimet Holdings (USA)

Cronimet Corporation

United Alloys & Metals
Cronimet GmbH

- Established 1980
- HQ in Karlsruhe, Germany
- 56 subsidiaries, partnerships, and representative offices
- Over 60 sales and processing operations
- Approx 5,500 employees worldwide

- Two aerospace scrap processing facilities:
  - Metalloy–Norderstedt, Germany
  - Karlsruhe, Germany
United Alloys and Metals, Inc

- Established 1973
- Focus on Titanium and superalloys.
- Acquired by Cronimet 2002
- Global purchaser, processor, and supplier of aerospace scrap products.
- Provides collection and processing services around the world.
- Approved to provide destruction services. (AFRA certified for recycling)
Los Angeles Facility
• 2014: Completed relocation to Santa Fe Springs
• 144k sq. ft. site with 75k sq. ft. warehouse
• Totally separate departments for various product line.

Columbus Facility
• 18 Acre Site with 12 acres under roof
• Totally separate buildings for various product lines

$10,000,000 invested in expansion in two years
Examples of Product
Advantages to using titanium scrap:

1) Scrap reduces product Cost.
2) Scrap supplements the supply of raw material (sponge/master alloy), especially during times of shortage.
3) Recycling scrap is the right thing to do for the environment.
Advancements in titanium melting technology drive scrap usage while advancements in scrap processing technology increases supply of scrap to the industry.
Early Patents

6/7/54: Patent applied for using “Compacted Electrode formed of Titanium Sponge”

8/19/55: Patent applied for “making consumable titanium electrodes by forming pieces of titanium scrap of various sizes, shapes, and characteristics”
Vacuum Arc Remelting (VAR)
VAR Scrap Usage

- **Advantages:**
  - Scrap can now be included in raw material mix.

- **Disadvantages:**
  - Welding electrodes is time consuming and does not lend itself to small or odd shaped pieces.
  - VAR Melting does not remove HDI contamination.
  - Turnings use extremely limited.
  - Scrap processing in the early stages.
8/17/69: Patent applied for NC furnace. NC furnace can use “Material feed in the form of powder, pellet, wire, and rod”. “The necessity and expense of forming an electrode of the material to be charged is obviated”.

Non Consumable Electrode Furnaces
Non consumable Furnace scrap Feedstock forms
Non Consumable Furnace Scrap Usage

- Advantages:
  - Small solids and turnings could now be included in raw material stream.

- Disadvantages:
  - Scrap sortation of small solids expensive and inexact.
  - Scrap processing had not as yet solved the turnings HDI contamination issue.
Scrap Processing Advances

- X-ray of titanium chip allows for removal of inclusions.
- First Generation of XRF production sorting equipment becomes available.
6/8/89: Patent applied for “Relates to cold hearth melting of metals such as titanium alloys which must be completely free of unrefined inclusions”
Electron Beam Cold Hearth Furnace

- Processed Feed
  - Sheet/skeleton scrap
  - Bar Ends
  - Rod and wire
  - Tubing
  - Forge Flashings
  - Fasteners
  - Medical implant
  - Turnings
Cold Hearth Melting Scrap Usage

Advantages:

- Processed turnings can now be used without X-ray due to hearth’s ability to remove HDI’s (substantially increasing the volume of titanium turnings returning to the titanium industry.)
- Technology drives increase in melting capacity to melt titanium feedstock (small solids, cobble, turnings)
- Game Changer!

Estimated that there are now 14 cold hearth furnaces operating in the United States alone.
Scrap Processing Advances-1990’s

- Major advances in OES sortation equipment.
  - Material can now be accurately sorted on the shop floor by generators, processors, and producers.
  - Portable sortation equipment allows for alloy identification outside of the scrap processing facilities.

*Process continues to be an expensive labor intensive piece by piece process.*
The next step: Capturing more of the scrap stream for titanium production

- Titanium industry must find a way to retain more of the scrap titanium units that are generated.
- It is estimated that *50% of all titanium scrap generated goes to Ferro-titanium or other sacrificial applications.

*USGS estimated 25,000,000 lbs of scrap used by steel and other industries in 2014
“Of the 55 million pounds of superalloy scrap processed in 1986, about 70 pct. (38.5 million pounds) was recycled in to the same superalloy”
Opportunities:

- Better segregation at point of generation.
- Scrap consideration during product and process development.
- Improvements in scrap sorting and processing.
- Future advancements in melt technology?
Challenges:

- **Cost Reduction!**
  - Processing costs
  - Logistics
  - Packaging/administration/Financing

- **New and better manufacturing processes will effect scrap availability and require new innovative scrap processing technologies:**
  - Powder Parts
  - 3D manufacturing
  - Improved machining
How does titanium scrap get from generator back to the furnace?
The Early Years

- Producer
- Scrap Generator
- Scrap Dealer/Broker
- Local Scrap Yard
- Scrap Processor
Disadvantages

- Too much added cost without added value.
- Material subject to speculation at all levels.
- Little or no traceability of material.
Buyback era begins (1980’s)
Advantages/Disadvantages

- **Advantages:**
  - Price stability
  - Supply stability
  - Increased Traceability

- **Disadvantages:**
  - Difficulty matching melt schedule with material return.
  - Price discrepancies with spot market.
  - Difficulty using “off grade” material.
Aerospace industry consolidates as companies integrate up and down the supply chain.

This Consolidation combines titanium producers and major scrap generators under the same corporate logo.

With control of more of the scrap stream, producers increase internal scrap processing capabilities.
- Producer
- Scrap Generator
- Scrap processing
The future of the Scrap Processor

- Scrap Processors with world wide foot print will:
  - Provide collection and consolidation services around the globe.
  - Provide toll processing services to the industry.
  - Purchase and consolidate material from small generators for processing and sale to producers.
  - Act as a “buffer” during periods of inventory shortage and overhang.
  - Continue to develop markets for off grade products.
  - Provide innovative products and solutions to the industry.
Summary

- Scrap supplements sponge and master alloy to provide substantial low cost units to the market place.
- Advancements in melting and processing technology has allowed for the continuing increase in titanium scrap recycling.
- Titanium industry needs to continue to move towards capturing a bigger percentage of the scrap stream.
- Implementation of buy back programs along with industry consolidation has stabilized both pricing and supply of scrap to producers.
- Scrap processing industry continues to provide valuable product, services, and innovation to the titanium industry.