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Recycling Gallium, Rhenium, Indium

Key Business Factors

Dr. Larry Seeley
Vice President, Corporate Development
March 23, 2011
Business Factors in Recycling

- Introduction and Scope of Considerations
- Market and Product Factors Worldwide
- Procurement and Commercial Methodology
- Technology Considerations
- Operations Essentials
- Financial Needs
- Organization Required
- Summary of Needs for a Business to be Sustainable
Scope of Considerations in Recycling

- Very Complex Business
- Feeds Highly Variable
- Form, Composition, Impurities, Quantities, Location
- Wide Range of Feed Values
- Metal Content Difficult to Determine
- Many feed Preparation Methods Needed
- Technically Complex Processing Methods Required
- Highly Different Metal Recoveries
Where Neo Gallium Products Go

Gallium 6N, 7N & MBE Purity

Wireless Communications
Satellite Radar

Cell Phones
Power Amplifiers
Switches

Military Applications
Satellite
Night Vision
Radar
Communications

GaAs

GaAs

GaAs, GaN
GaP

LED’S
(Light Emitting Diodes)
Lighting Indicators

Laser Diodes
Compact Disc Readers
DVD Readers

GaN
Where Neo Gallium Products Go

Gallium 4N to 5N Purity

Alloys
- Thermometers
- Eutectics

Gallium Compounds
- Gallium Tri-chloride
  For semiconductors

Magnets

Gallium Compounds
- CIG(S)

Solar Cells

Optical Electronics

Oxides

CIG(S)
Where Neo Gallium Products Go

Purification to 99.9999 + 99.99999% + MBE

Neo Capacity +50,000 KG
Where Neo Gallium Products Go

Gallium Nitrate

Pharmaceutical
- Navicular Disease
- Arthritis

Catalysts
- Petrochemical
- Styrene
Where Neo Indium Products Go

Indium Metal 99.999%

- Solar
  - Copper Indium Gallium Selenium (CIGS)
- ITO
  - Indium Tin Oxide (ITO)
- Television Screens
  - FBD
  - Monitors
- Coatings
  - High speed bearings
  - Transistors
  - Rectifiers
  - Mirrors
- Low Melting Alloys
  - Thermometers
  - Eutectics
  - Solders
Where Neo Rhenium Products Go

- Metal Pellets  - Hot Section of Jet Engines
  - Alloys, Thermocouples

- High Purity APR  - Catalysts for Petroleum Refining
Recycling Gallium, Rhenium, Indium 2010

- Hazardous Materials Needs in Transportation, Processing and Waste Handling
- Widely Different Commercial Terms
- Huge Amount of Client Interaction
- Need to Deliver Different Products
- Must have a Critical Mass of Recycle Materials for a Sustainable Business
- Each Feed Type is like Processing a New Ore
Market and Product Factors

- Recycling from Manufacturing Facilities and Traders
- Scrap from Many Products and in Many Forms
- Large Range of Lot Sizes from 10 kg to Tons
- Small Market but Worldwide Business
- Market Supply Dependent on Recycling
Types of Recycling Feed Gallium

- GaAs Wafers and Chunks
- GaAs Kerf and Sludges
- GaAs Filters, Hard Residues
- Ga and Indium Residues
- Ga Metal and Alloy Scrap
- Ga electronic scrap
- Copper Indium Gallium Selenide scrap
- Gallium in Solutions
Type of Recycle Feed Rhenium

- Superalloy Turbine Blades with and without Refractory
- Superalloy wet Swarf and containing oil
- Superalloy Swarf on filters
- Superalloy wet Grindings, containing oil and grinding media
- Various forms of MoRe and WRe
Market and Product Factors

• Recycling from Manufacturing Facilities and Traders
• Scrap from Many Products and in Many Forms
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• Small Market but Worldwide Business
• Market Supply Dependent on Recycling
Procurement and Commercial Methodology

- Global Procurement Organization
- Extensive Trader Network
- Close Interaction with Users of Our Products
- Purchasing and Tolling
- Transportation and Permits
Global Footprint – Gallium, Rhenium & Indium
Procurement and Commercial Methodology

- Global Procurement Organization
- Extensive Trader Network
- Close Interaction with Users of Our Products
- Purchasing and Tolling
- Transportation and Permits
Technology Considerations

Extensive Feed Preparation Capabilities
- Drying
- Calcining
- Screening
- Size Reduction
- Blending and Sorting

Highly Accurate Sampling and Analytical Analysis

Wide Capability in Leaching
- Reductive Leaching
- Oxidative Leaching
- Multi-Stage Batch Leaching
- Solid – Liquid Separation
Technology Considerations

Metal Separation and Purification

- Precipitations
- Solvent Extraction
- Ion Exchange
- Cementation
- Electro Winning
- Electro Refining
- Hydrogen Reduction

Product Purifying, Casting and Packaging
Operations Essential

- Extensive Process Flexibility
- Critical Mass of Materials for Planning and Throughput
- Large Unit Operations
- Flexible and Experienced Workforce in Process and Metals
- Extensive Process Monitoring to Control Chemistry
- Job Shop Operations Methodology in a Line Organization
Gallium and Indium Recycling

Peterborough, Ontario

- Capacity 36,000 kg/yr
- Ga recycling 5-50% Ga producing 4N metal
- In recycling 5-60% In producing 5N metal
Blanding, Utah

- 30,000 sq. ft. of plant and warehouse
- Ga Recycling of high purity GaAs
- Gallium Chemicals
- Upgrading and Purification to 50,000 kg/yr
Rhenium Recycling

Napanee, Ontario
Rhenium and Tantalum Recycling

Products:
- High Purity Rhenium Pellets
- High Purity APR
- 4N Tantalum
Operations Essential

Plus Normal Plant Needs Such as:

- Health and Safety
- Environment Control
- Cost Containment and Accounting
- Effective Human Resource Practices
- Purchasing and Transportation
Financial Needs

- Significant Investment in R & D
- Considerable Engineering and Plant Investments
- Very High Working Capital in Inventories
- Global Contracts, Clients, Purchase and Sales
- Significant Delays in Revenue Recognition
- Operative Bank Lines and Long-Term Debt Capability
Organization Required

- Procurement
- Technology
- Operations
- Sales and Marketing
- Strong Financing Capability
- Primary Production is a Key Facilitator to Recycling
Primary Gallium
Summary for a Sustainable Recycling Business

- Recycling is a highly complex business
- Needs global procurement organization
- Needs strong financial capability
- Needs extensive development of technology & operations
- Needs extensive product scope and sales capability
- Best if added to a primary line operation