MATERION

Materion Flibe/Flinabe Salts

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Materion Corporation - Mission

- We manufacture **materials that enable technologies** to provide a safer and more sustainable future
- We provide exceptional value to our customers globally through **innovative technology and service**, and continuous supply chain improvement
- We are passionately focused on being our **customers' first choice**
- We design, manufacture and distribute our products in a safe, **environmentally responsible** manner

materion.com

OUR COMPANY

Global Footprint

3,000 +

Employees are serving our customers

34

Company facilities

10

In 10 countries around the globe

Manufacturing Facilities

Albuquerque, New Mexico
Bloomfield, Connecticut
Brewster, New York
Buffalo, New York
Delta, Utah
Elmore, Ohio
Fremont, California
Limerick, Ireland
Lincoln, Rhode Island
Lorain, Ohio
Milwaukee, Wisconsin
Reading, Pennsylvania
Santa Clara, California
Singapore
Subic Bay, Philippines
Suzhou, China
Taipei, Taiwan
Tucson, Arizona
Tyngsboro, Massachusetts
Westford, Massachusetts
Wheatfield, New York
Windsor, Connecticut

Service Centers

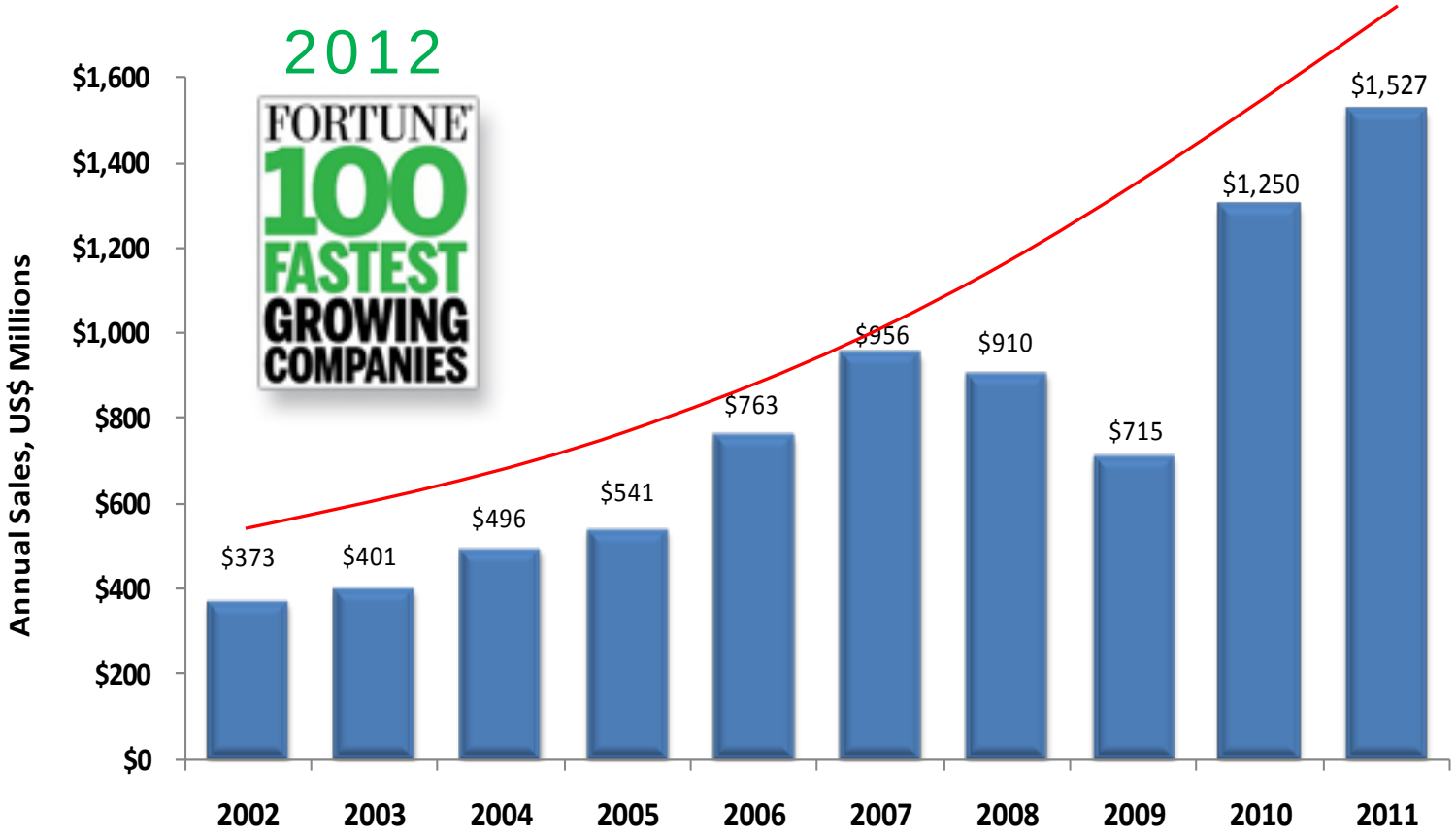
Elmhurst, Illinois
Warren, Michigan
Singapore
Stuttgart, Germany
Theale, England
Tokyo, Japan

Business Units

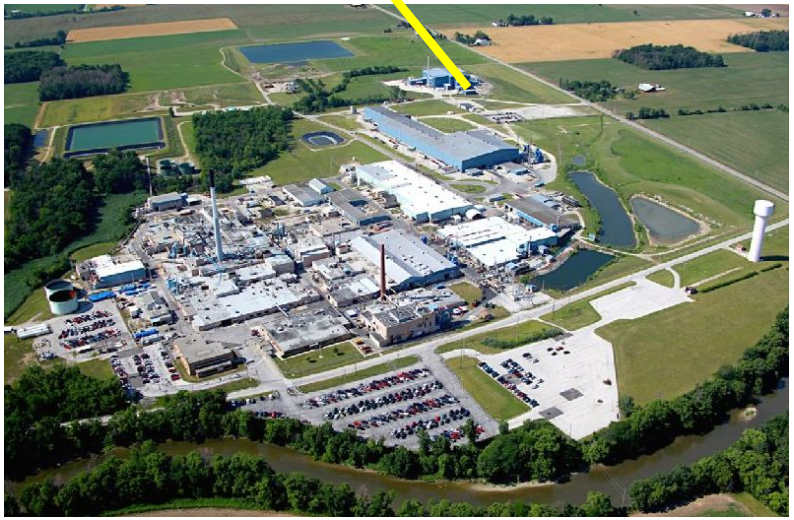
- Advanced Materials Technologies & Services:
  - Barr Precision Optics & Thin Film Coatings
  - Microelectronics & Services
  - Advanced Chemicals
  - Large Area Coatings
- Technical Materials
- Materion Brush (fka Brush Wellman):
  - Brush Beryllium & Composites
  - Brush Performance Alloys
  - Natural Resources
  - Electrofusion and Ceramics

OUR COMPANY
Financial Position

No. 59 on *Fortune* magazine's 2012 list of the 100 Fastest-Growing Companies. September 24, 2012



Materion Brush - Elmore, Ohio Facility



- The Title III Program entered into a partnership with Materion Corporation initiating construction of the beryllium "Pebbles Plant" in Elmore, Ohio.
- Production capacity high-purity beryllium metal ensures domestic and foreign consumption.
- The plant stands 73 feet tall, contains three levels, has a 51,045 sq. ft. footprint, and contains 124,358 total square feet of floor space.

Materion Brush – Divisions

Beryllium & Composites

- Beryllium
- Elevated beryllium containing materials
- Non-beryllium composite materials
- Beryllium chemicals
  - Sulfates,
  - acetates,
  - oxide

Performance Alloys

- Low beryllium containing alloys
- Resource recovery operations

Flibe Salts

- The first major use of Flibe for nuclear power applications was in the 8 MWth Molten Salt Reactor Experiment (MSRE) constructed at Oak Ridge National Laboratory (ORNL)
- Operating between June 1965 and May 1969, the MSRE used a mixture of 66 mole% LiF and 34 mole% BeF_2 at 545 to 650°C, 34.4 kPa gauge pressure, and 54 L/s circulation rate as an intermediate coolant
- MSRE operated successfully for 17,655 critical without any extreme personnel safety events (i.e., no radiation exposure over 15 rem, and no fatalities or life-threatening injuries)

General characteristics of Flibe

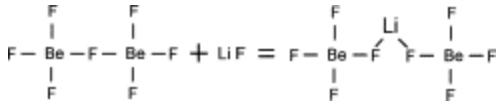
- Flibe itself is not a combustible material
- Flibe does not melt until over 455°C
- Flibe recombines reasonably fast from radiolytic decomposition
- Flibe can attack Mn in stainless steel, so erosion products from wall materials are possible
- Designers may add an anticorrosive like MoF_6
- The addition of beryllium metal (i.e. beads) helps control the Redox potential

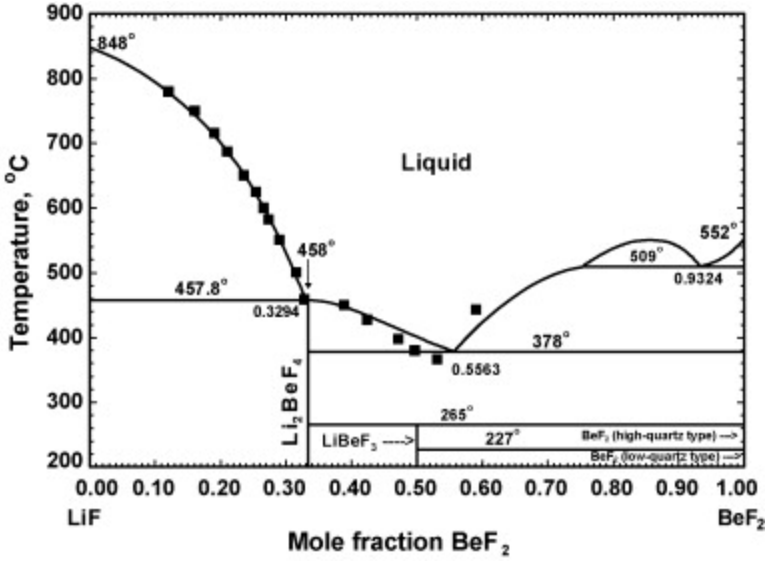
Physical Properties of Flibe

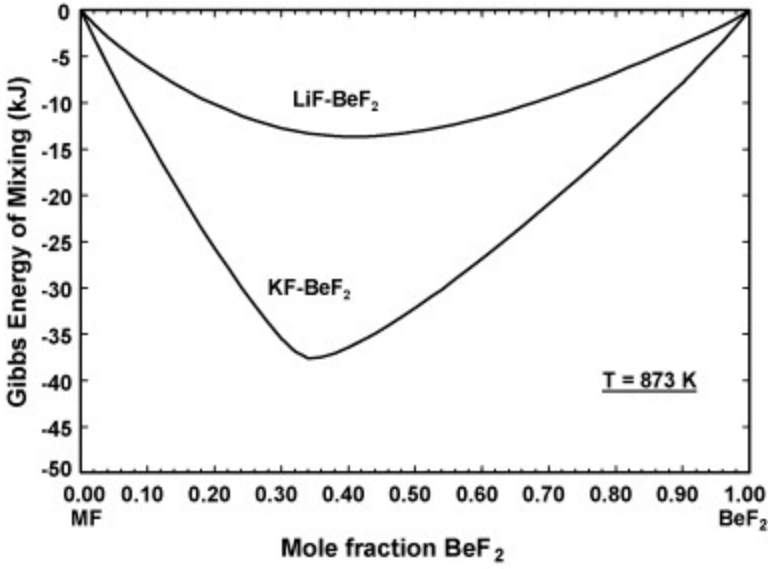
Property (T is in °C)	66 mole% LiF – 34 mole% BeF_2
Liquidus Temperature, °C	458 ± 1
Density of Liquid, g/cm^3	2.214 – 4.2 x10^{-4} T ± 2%
Thermal Conductivity, W/m.°C	1 ± 10% (for a 200°C range)
Solid Heat Capacity, cal/g.°C	0.317 + 3.61 x 10^{-4} T ± 3%
Liquid Heat Capacity, cal/g.°C	0.57 ± 3%
Heat of Fusion, cal/g	107 ± 3%
Viscosity, cP (T in Kelvin)	0.116 exp(3755/T) ± 25%
CTE (volumetric), ppm/°C	2.1 ± 20%
Vapor Pressure, Torr (T in Kelvin)	log P = 9.024 – (5920/T) ± 10%
Electrical Conductivity, ohm-cm^{-1}	1.54 + 6.0 x 10^{-3} (T-500) ± 10%

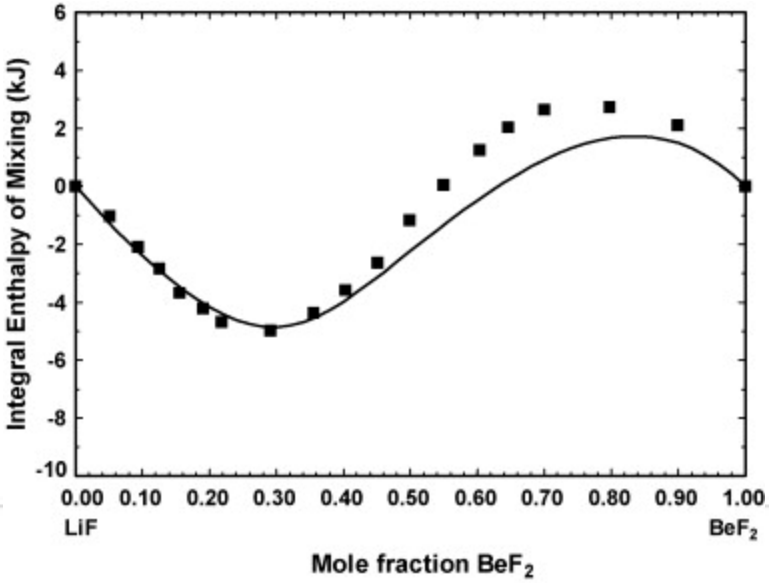
S. Cantor, et al. (1968), "Physical Properties of Molten-Salt Reactor Fuel, Coolant, and Flush Salts," ORNL-TM-2316

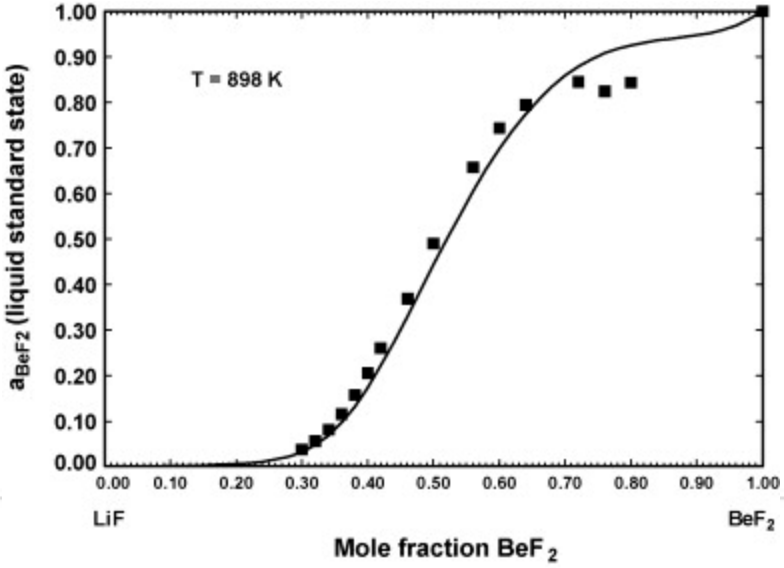
Thermodynamics of Flibe





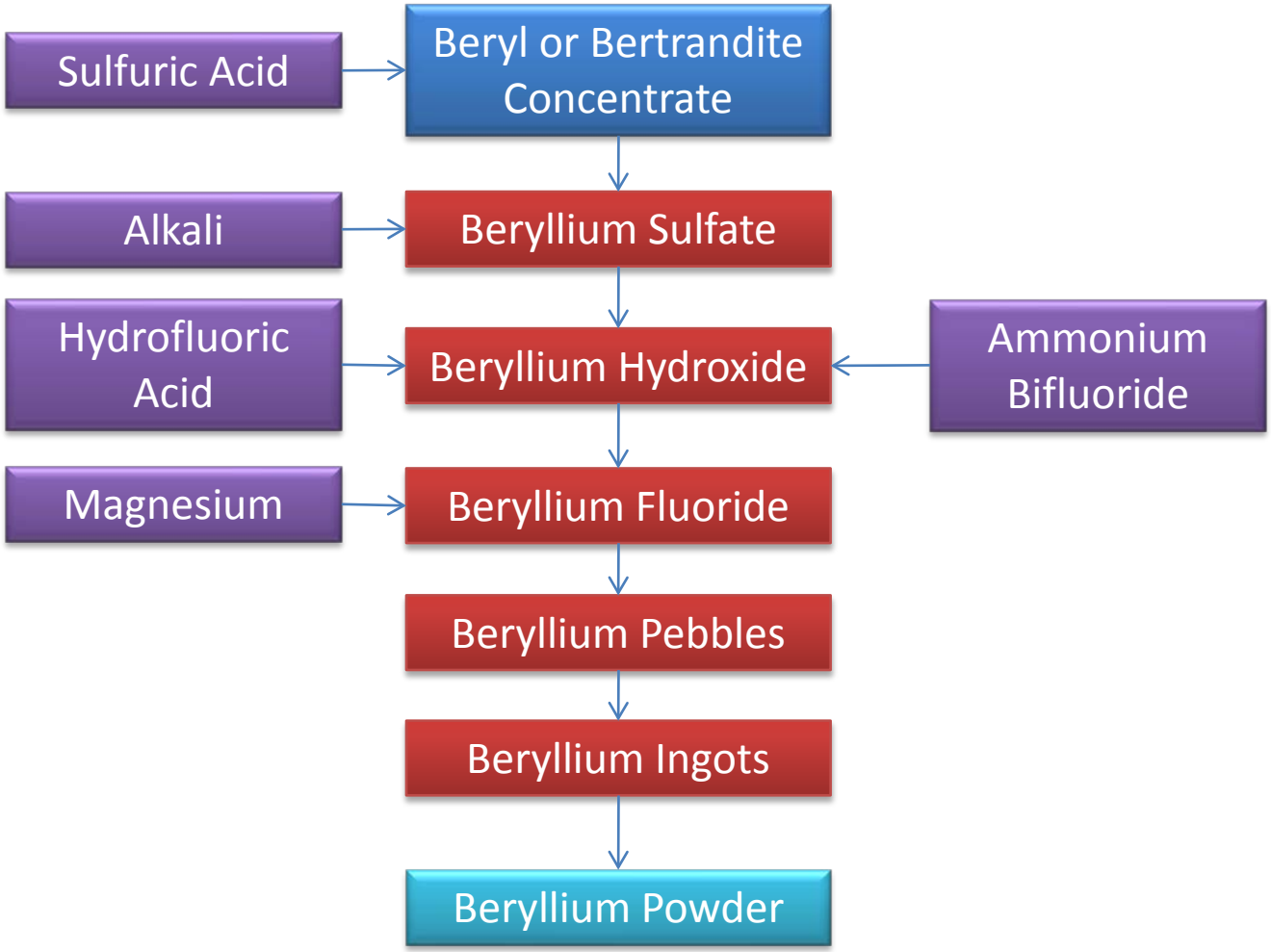




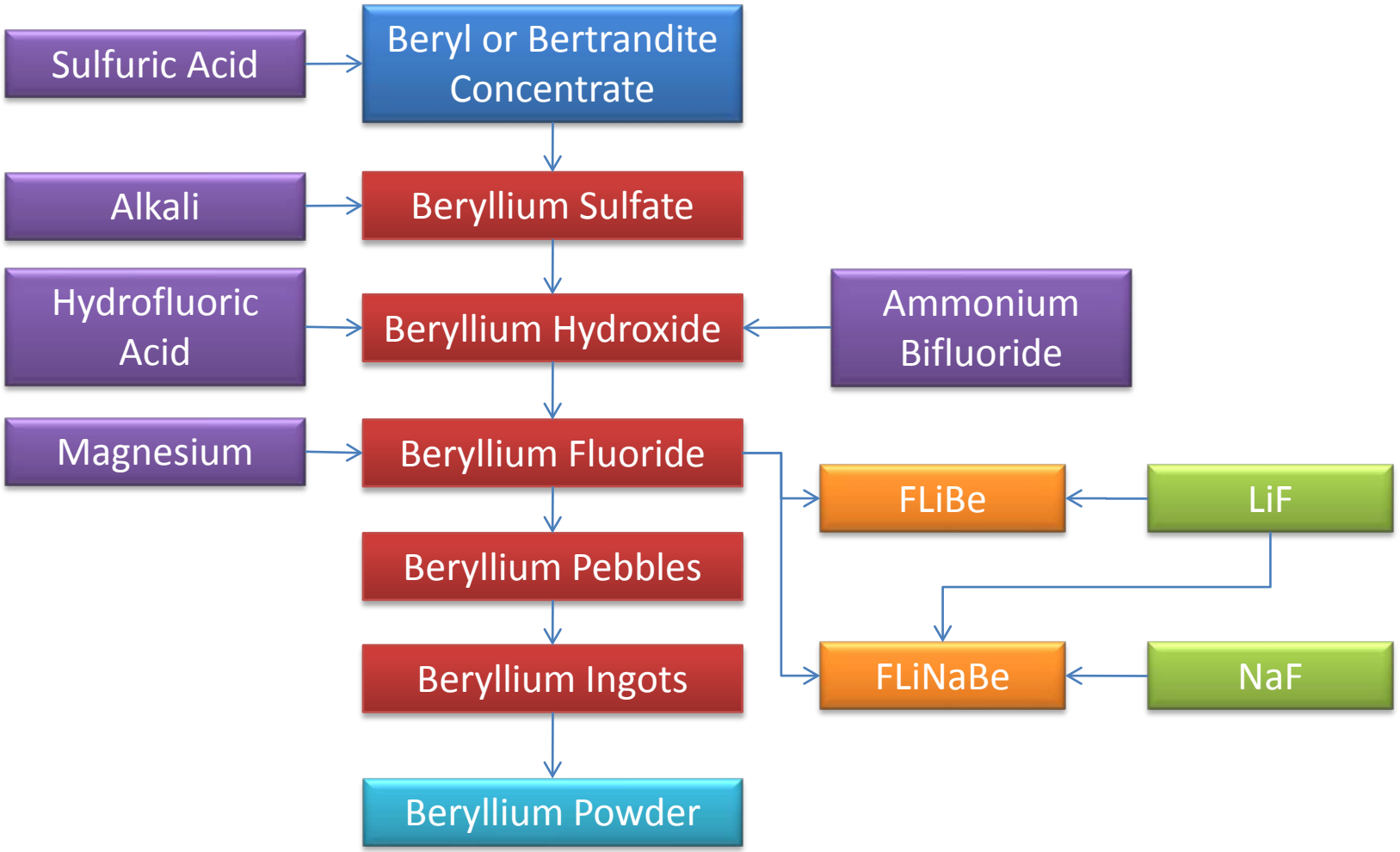


Romero-Serrano, et al. (2009), Thermodynamic analysis of LiF–BeF2 and KF–BeF2 melts by a structural model, Journal of Fluorine Chemistry, 130 (3) pp. 336-340.

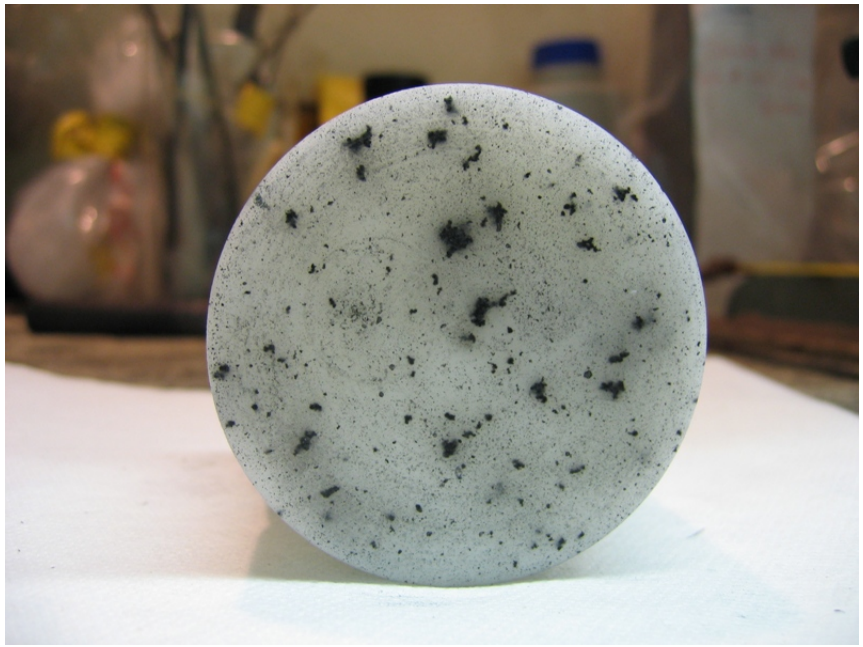
Materion's beryllium extraction process

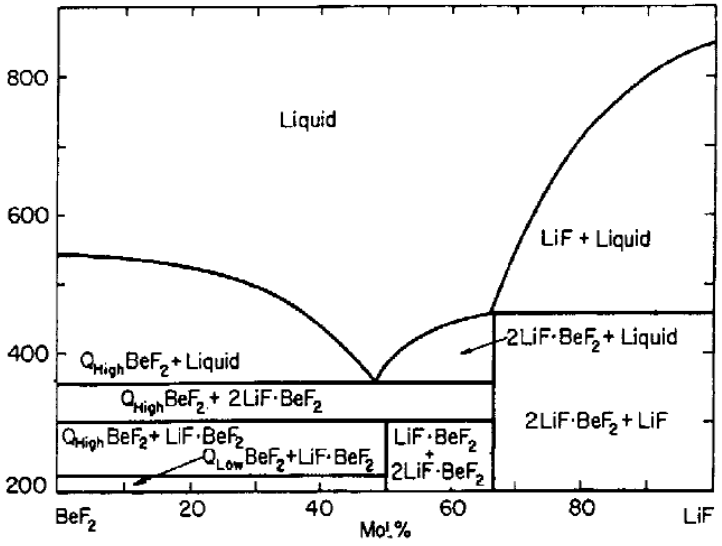


Materion's beryllium extraction process – modified

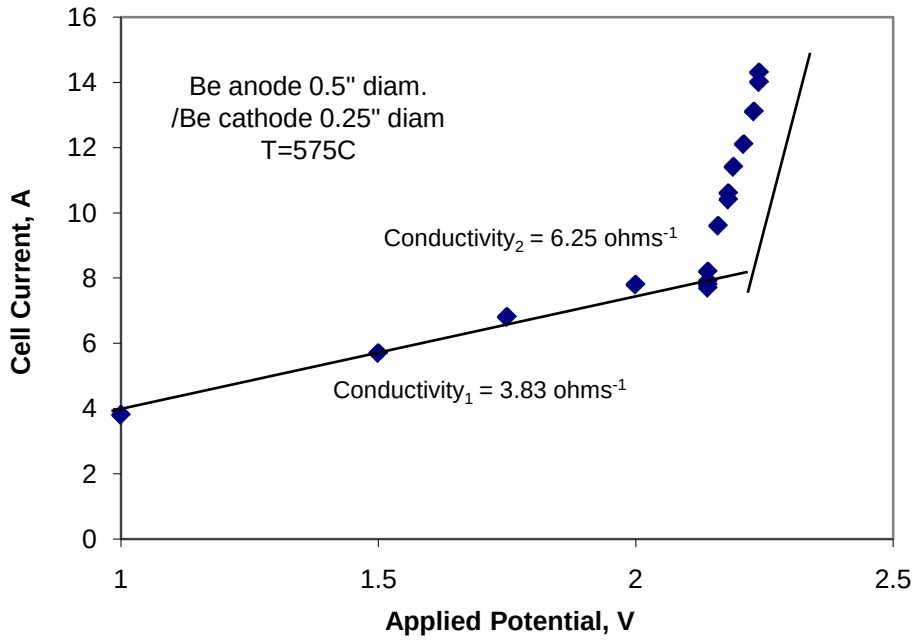


Production in Elmore





Flibe/Flinabe Characterization



Summary

- Materion provided Flibe to the MSRE at ORNL and will provide it to the next generation of reactors
- A proprietary process has been developed and will be implemented into the extraction process once the market demands it
- Materion will assist its customers in adjusting chemistries, adding corrosion inhibitors and evaluating its properties
- For questions and more details: edgar.vidal@materion.com