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GeoMelt Vitrification
Life Cycle Benefits for the Treatment of Toxic and Radioactive Wastes

Presented at the SafeSpur Forum

18 November 2009, Chorley

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Brief History

- IMPACT Services, a radioactive waste management company with 4 locations and 2 licensed processing facilities in the US, acquired GeoMelt from AMEC in March, 2009
- IMPACT will use the GeoMelt technology for fixed-based processing of toxic, hazardous, and radioactive wastes generated by both commercial and government clients
- In the UK, IMPACT has teamed with AMEC to continue proof of process demonstrations at AMEC's Birchwood Facility

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GeoMelt®

- Electric melting of contaminated soils and wastes
- Soil normally provides source of glass formers
- In-situ or In-Container Vitrification
- Melt temperatures 1300-2000 deg. C
- Volume reduction typically 25% to 50%, more for other wastes
- Off-gases captured and treated
- Majority of organics destroyed by melt with balance removed by off-gas treatment system (OGTS)
- Heavy metals and radionuclides retained in melt and immobilized in glass product or removed in OGTS
- Batch processes with rates to 100 MT / day

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Two Primary GeoMelt® Treatment Configurations

In-Container Vitrification™ (ICV)

In-container treatment

Subsurface Planar Vitrification™ (SPV)

In-situ treatment

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GeoMelt® Capabilities

- Applicable to most all contaminant types and mixtures
  - heavy metals
  - inorganic compounds
  - radionuclides
  - organics
- Successfully treated organic waste loadings >30 wt%
- Treated wide range of soil types (sands, silts, clays, gravels)
- Applicable to wet soils, sludges, sediments, ash (up to 70% water)
- Treat liquid wastes by first mixing with soil
- High tolerance for debris (steel, wood, concrete, tires, etc)
- Effective on asbestos wastes (asbestos provides glass formers)
- Permitted for PCBs by the U.S. EPA
- Selected in Australia as an alternative to incineration

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Partial List of Materials Treated with GeoMelt®

Metals	Organics	Debris	Radionuclides
Pb	PCBs	Wood	Pu
Cd	Dioxins / Furans	Tires	U
Cr	TCE / PCE	Asphalt	Cs
Ni	Carbon Tetrachloride	Plastic	Sr
Ba	Benzene / Toluene	Concrete	Co
Zn	Acetone	Steel Plates	Ru
Hg	Formaldehyde	Drums	Am
Cu	Methylene Chloride	Rocks	Ra
Al	Ethylene Glycol	Bricks / Clay Pipe	Rd
Fe	Methyl Ethyl Ketone	Glass Bottles	Tc
Nd	Pentachlorophenol	Ash	
Rb	HCB	Asbestos	
Be	DDT, DDD, DDE	Tanks	
As	Lindane	Filters	

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Examples of Waste Loadings Demonstrated

Material	Configuration	Loading
Plutonium	Soil / Debris	80 to 175 GBq / melt
PCBs	Soil / Debris	17,863 mg/kg
Dioxin	Soil / Debris	38 mg/kg
Pentachlorophenol	Soil / Debris	6,950 mg/kg
Pesticides	Soil	>4 wt%
Hexachlorobenzene	Soil / Debris	33 wt%
Lindane	Soil	33 wt%
Concrete	Soil / Debris	8 wt% at FS
Asphalt	Soil / Debris	75 wt% at ES
Iron/Steel	Soil / Debris	11 wt%
Drums	55-gal	37 wt%
Asbestos	Fiber Mat	20 / melt setting
Water	Sludge	72 wt%
		70%

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Minimal Energy Usage

- Common misconception that GeoMelt® requires lots of power
- Energy requirement for GeoMelt® is about half of what other thermal processes require due to greater efficiency and less heat loss
  - Joule heating (resistive heating) within the body of the melt
  - *Heat "losses" occur at the melt boundaries and serve to pre-heat adjacent waste materials*
  - In ICV configuration, sides and bottom are insulated so most heat loss occurs at the top surface where waste material feed pile resides
- Energy for melting ranges from 0.6 to 1.5 kWh / kg of material melted
- Energy requirements for off-gas treatment and other services will be about equal for all treatment technologies

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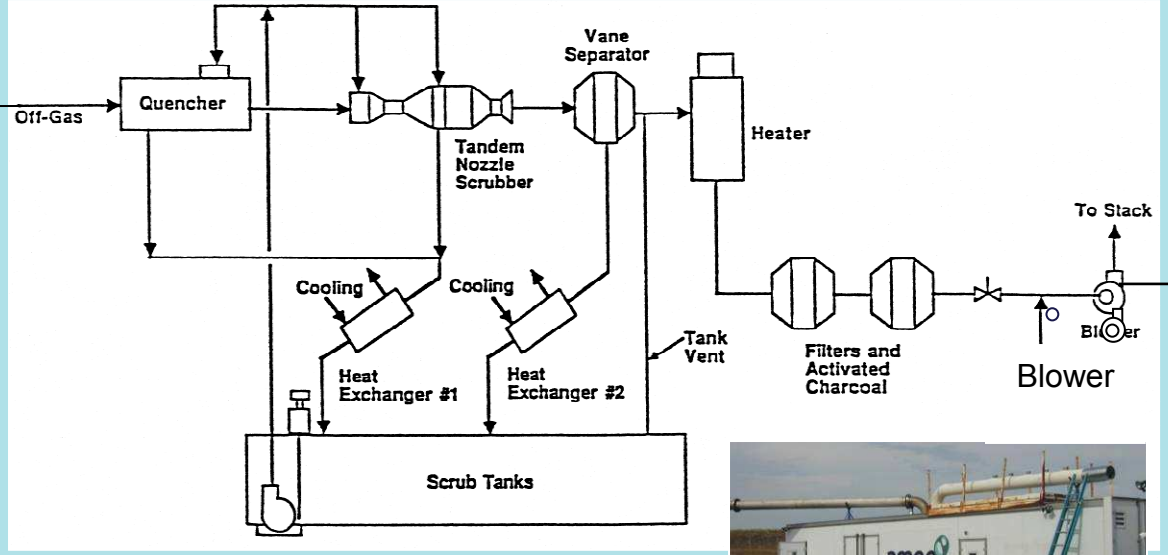
ICV™ Off-Gas Treatment

Bag House Filter

Off-Gas From Melt



Particulate Pre-Filters

Enclosed Inside Trailer

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Removal of Glass Block and Packaging for Disposal

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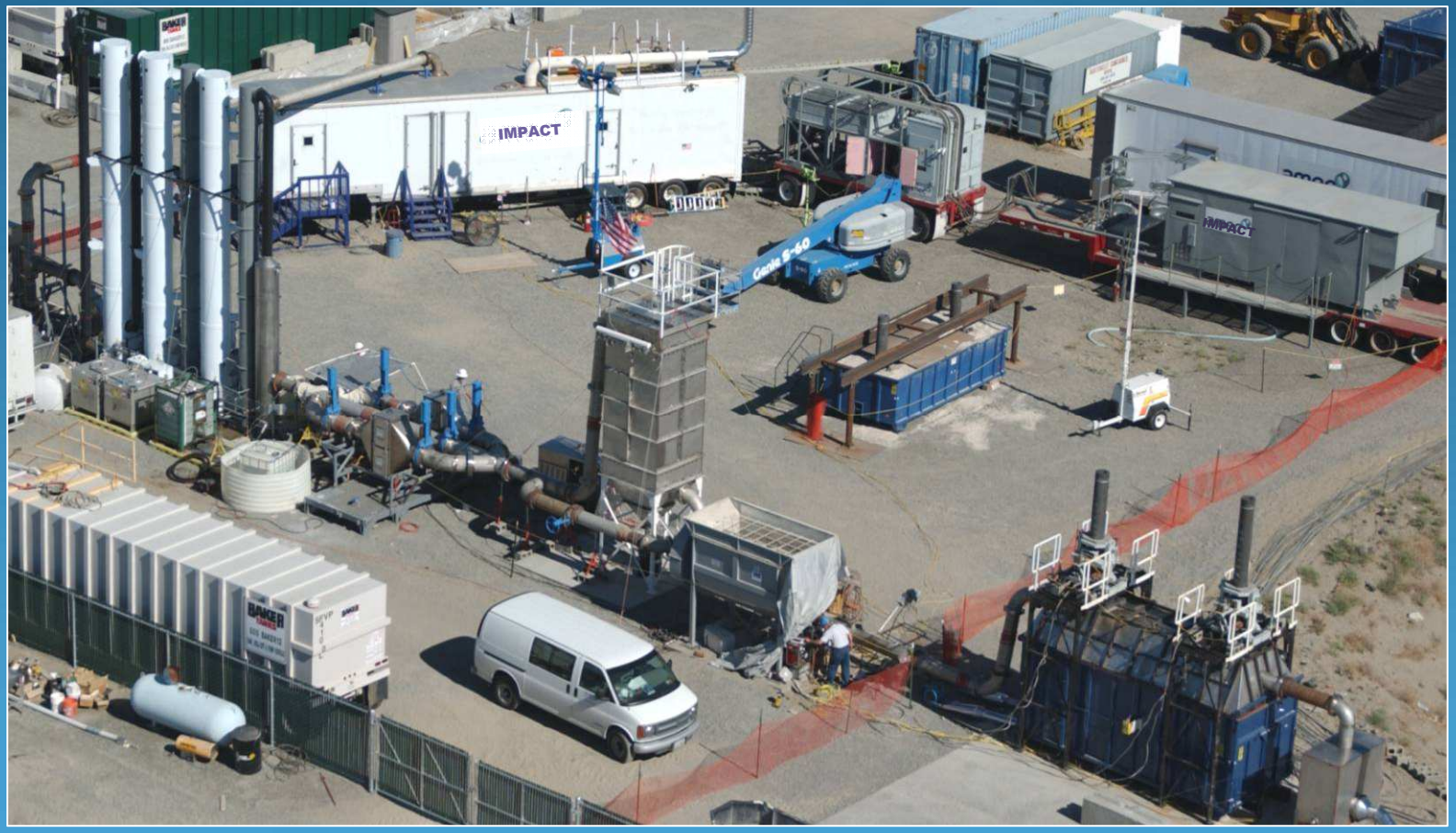
GeoMelt® Test Site



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ICV Pre-Treatment and Melt Process Equipment in Japan

Crusher for Concrete & Debris

Pre-treatment Mixer

Melt Container at Fill Station

Rail Mounted Box at Melt Station

Off-Gas Treatment Equipment

Liquid Effluent Treatment

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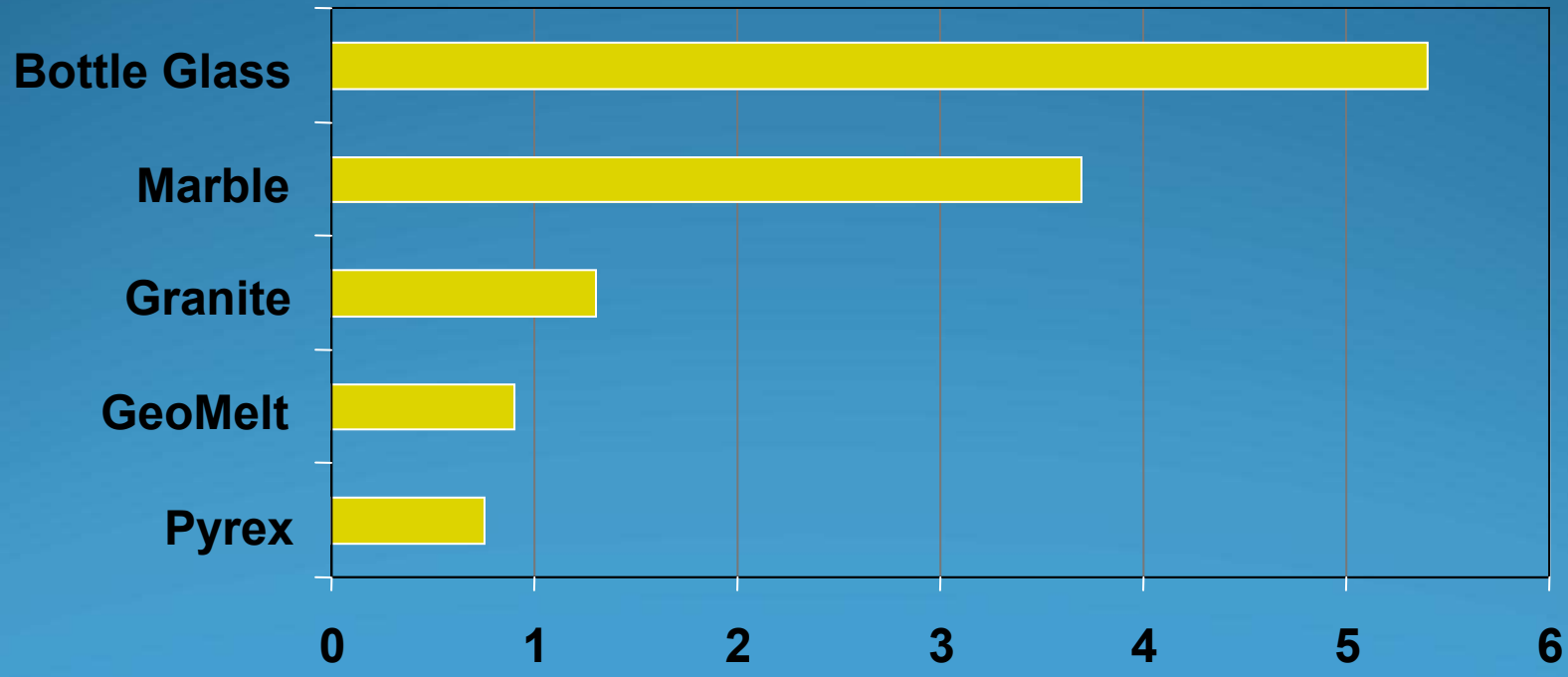
GeoMelt® Product Durability

Comparative Corrosion Rates

(Normally 10X to 100X more durable and leach resistant than HLW glasses)



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GeoMelt Glass Characteristics Compared to Cement-Based Waste Forms

Characteristic	Glass	Cement
Leach Resistance (ANSI 16.1)	LI of 14-18	LI of 6-8
Durability (years)	$>10^4 – 10^6$	10^2
Waste Loading	Generally higher	Limited
Compressive Strength (psi)	40,000 - 60,000	3,000 - 8,000
Tensile Strength (psi)	4,000 - 4,400	400 - 600
Volume Reduction	Decrease	Increase

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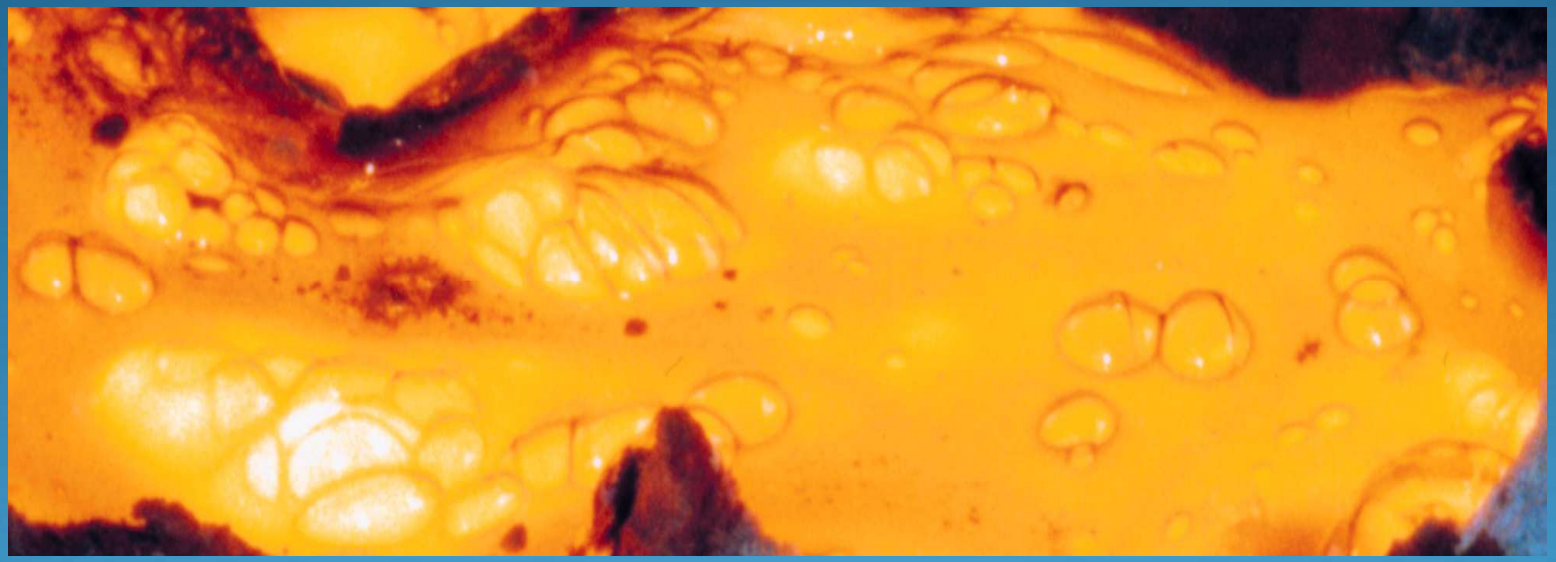
Melt Surface



Melt surface during the treatment of plutonium-contaminated waste

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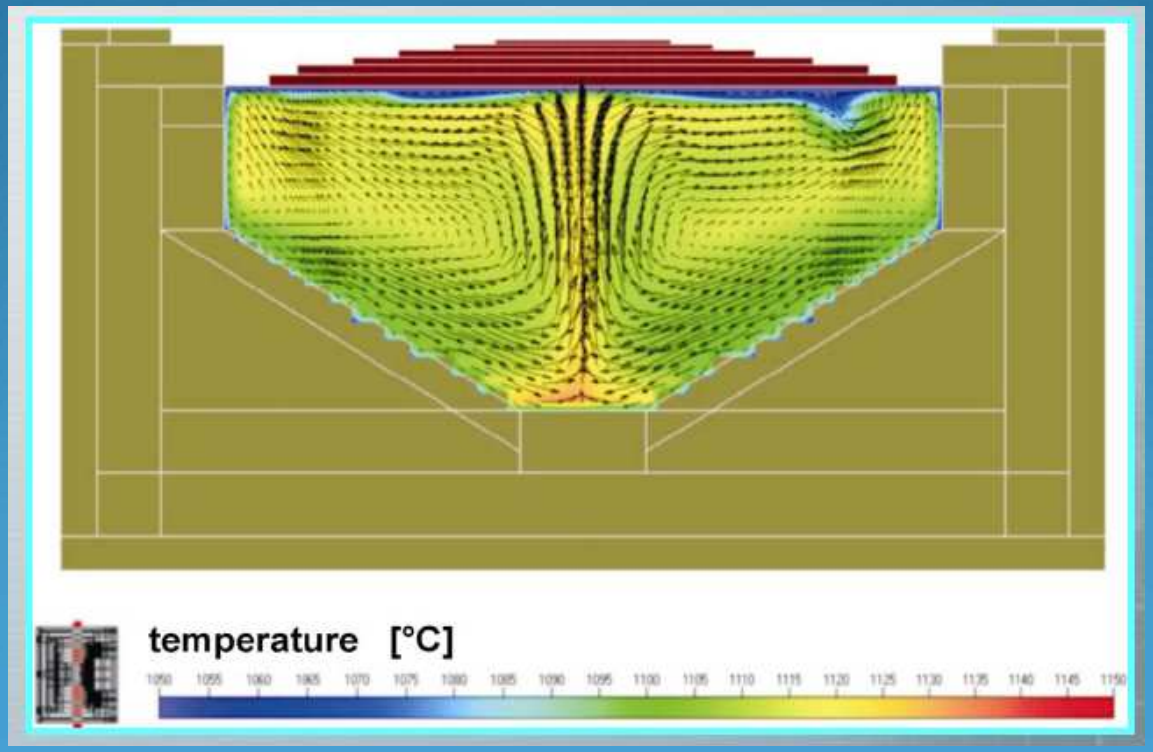
Joule Heating Results in Temperature Gradients Resulting in Convective Flows in the Melt Pool that Creates a Homogeneous Glass Product



Numerical Model Output of Tempest Model Showing Flow Velocities

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Staging Waste and Debris for 4 MT Demo Melt with Point Sources of 1 kg of U_3O_8 and ~0.5 g 239-Pu

- Soil
- Steel plate
- Lead sheet
- Barytes bricks
- Electrical Cable
- Bitumen
- Plastic
- PPE
- Pu and U located in center of treatment zone as point source

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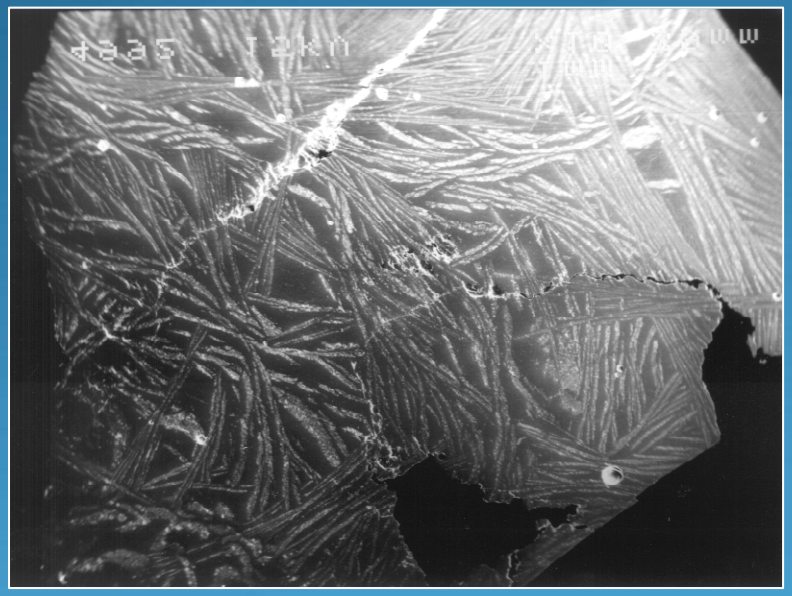
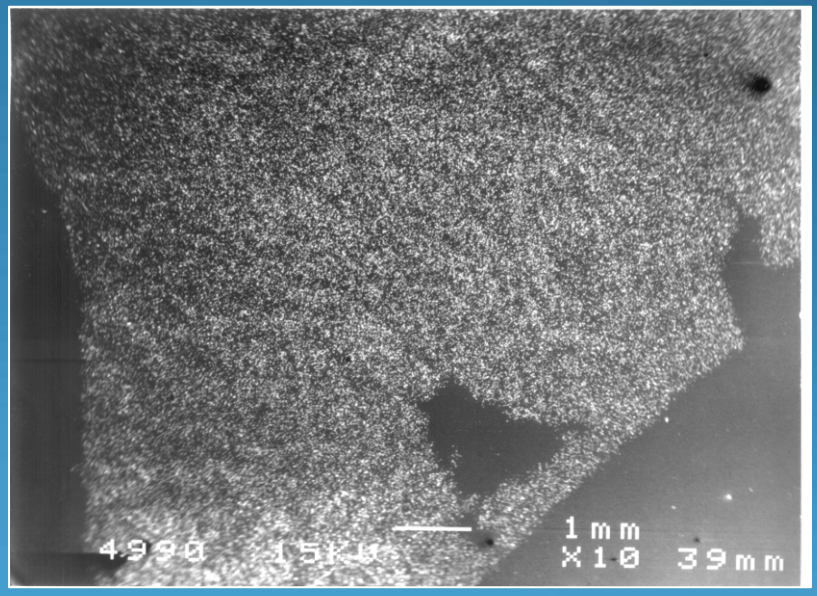
Thin Section of Vitrified Product (L) and Corresponding Image Showing Uniformity of Alpha Disintegrations (R)





Point Sources of Pu and U were incorporated as oxides uniformly in the vitrified product proving good convective mixing to form a homogeneous glass

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Benefits of GeoMelt

- Robust - accommodates highly variable materials
- Flexible - process and waste package are project specific
- Minimal pre-treatment - size reduction and sorting
- Soil based - an inexpensive source of glass formers
- Shielding - ICV package design provides inherent shielding
- In situ treatment if there is a high risk and cost of exhumation
- Volume reduction – typically 25 - 50% for soil, more for other wastes
- Excellent waste form – highly durable
- Demonstrated capability – proven in other applications
- Cost vs permanence – excellent value

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Key Differentiators for Using GeoMelt as the UK's Thermal Treatment Process

- GeoMelt has been *deployed successfully* at commercial waste treatment facilities and site remediation projects to treat *radioactive* and *hazardous wastes* around the world.
- GeoMelt is capable of simultaneously processing *organic*, *inorganic*, and *radioactive contaminants*.
- GeoMelt has a *high tolerance for debris* such as concrete, scrap metal, plastic, and wood.
- GeoMelt demonstrates unequaled residual product properties such as *leach resistance*, strength, and weathering resistance.
- GeoMelt has obtained a high degree of *public* and *regulatory acceptance*.
- GeoMelt will result in a final waste form that provides a disposition path for problematic waste streams.

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Schedule of Events for GeoMelt® in the UK

- GeoMelt Demonstration Unit scheduled for delivery and installation at AMEC's Birchwood Facility by March, 2010
- Followed by commissioning and training of UK staff
- AMEC's facility available for trial work to prove GeoMelt in the UK
- Ability to undertake active trials
- Associated waste management consultancy