

Beryllium Replacement

SBIR Phase I

Mirror Technology Days in the Government
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TRI/Austin, Inc.
Austin, Texas
Chris Thornton



Texas Research International, Inc.

- Texas Research Institute, Inc. (TRI)
 - Formed in 1975
 - Dr. J. Scott Thornton



- Materials Science
 - Problem Solving
 - Product Evaluation
 - Product Development



TRI/Austin

Corporate Structure

Mike Dingus – Vice President

- Engineering
 - Brian Muskopf
- Materials
 - John Bulluck
- Non-Destructive Evaluation
 - Russell Austin
- NTIAC
 - George Matzkanin



TRI/Austin

Applied Research and Product Development

- Polymer Chemistry
- Composites
- Non-destructive Testing
- Accelerated Life Testing
- Failure Analysis
- Creep
- Analytical Chemistry
- Protective Clothing
- Permeation
- Industrial Hygiene



Facilities



Marine Accelerated Life Test



MIL-883 Thermal Shock



Pipe NDE Test Stand



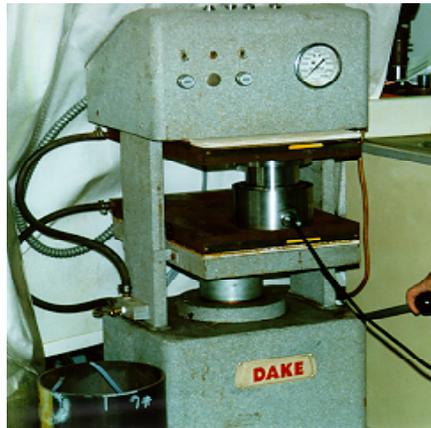
Thermal Analysis/FTIR



Facilities



Salt Fog Chamber



Prototype Mold Facilities



QUV Weatherometer



Environmentally Controlled
Material Testing



Capabilities

- Material Characterization, Evaluation and Selection
- Comparative Analysis
 - Manufacturing Costs
 - Maintenance Costs
 - Weight Savings
 - Strength
- CAD Part Design
- Finite Element Analysis
 - Stress
 - Thermal
 - Modal



Capabilities (continued)

- Tool Design and Fabrication
- Prototype Part Development, Fabrication and Testing
- Reliability Analysis
- Quality Control
- Nondestructive Testing and Inspection
- Production Part Fabrication
- Qualification Testing (ASTM, Military Standards, Custom)



Resin Systems Expertise

- **Epoxies** (solvent based or 100 % solids aromatic and aliphatic)
- **Silicones**
- **Polyurethanes** (solvent based and 100% solids, aliphatic and aromatic)
- **Polyureas** (aliphatic and aromatic, Jeffamine systems)
- Waterbased **acrylics**
- Waterbased polyurethanes



Composite Product Development

- Engineering Service
- Provided to Government and Commercial Clients
- Development of Composites for Harsh Environments
 - Seawater
 - Salt Water Spray
 - High Temperature Applications
 - Fire Resistant Applications
 - Chemical Exposures
- Specialty Composites
 - High Specific Gravity
 - Nontoxic



Elastomeric

Composite Material Characterization

- Testing Performed to Government and Industry Standards
- Testing Includes:
 - *Tensile*
 - *Flexural*
 - *Shear*
 - *Thermal Expansion*
 - *Creep and Stress Relaxation*
 - *Full Article Flame*
 - *Chemical Attack*
 - *Compressive*
 - *Impact (Izod , Vertical Drop; and Full Article)*
 - *Thermal Shock*
 - *Accelerated Life*
 - *Water Absorption*
 - *Gas Permeation*



Accomplishments:

Composite Submarine Sonar Transducer Mounting Bracket

- Eliminates corrosion damage extending life from 2 to 15 years
- Passed all qualification tests including explosive shock
- Brackets have been at sea on USS Louisville for over 7 years with no problems



Accomplishments:

Non-Toxic Polymer Composite Projectiles (*EcoMass*)

- Non-toxic polymer composite material has density of lead
- Other physical properties can be tailored to the application
- U.S. Army scheduled to replace all small calibre lead projectiles with *EcoMass* by 2005



Beryllium Replacement: Background

- Used in the EKV for optics & structures
small volume
- Commodity:
Be-Cu alloy structural and electrical material
75% of Be tonnage
- Beryllia electronics substrates
highest performance



Beryllium Replacement: TRI's Approach

- Holistic approach: Beryllium will be banned from all uses, not just EKV
- Unbiased approach: TRI does not endorse any particular replacement technology
- Present technologies: Assessment of the many technologies in place already
- Future technologies: Identification of new technologies



Beryllium Replacement:

First Step: Identify Critical Applications

- Elemental metal 10%
 - brakes, EKV housings/sunshield/mirrors, marine anti-fouling
- Alloy 75%
 - dental material, oil & gas drilling, bushings, bearings
 - molds, spring contacts, connectors, and switches for telecommunications, computers, radar, aerospace, instruments
- Ceramic 15%
 - electronics substrate

.....and many more.



Beryllium Replacement:

Develop Reference Table of Alternatives for Each Use

- **Thermal:** CTE, c_p , K, T_m , T_g
- **Physical:** density, hardness, strength, modulus, toughness, yield strength, fracture toughness
- **Chemical:** corrosion, electronegativity, atomic radius, crystal structure
- **Electrical:** conductivity, magnetic permeability
- **Optical:** polishability, reflectance



Beryllium Replacement: Identify Existing Solutions

- **Space mirrors:** SiC, MMCs, PMCs, glass
- **Electrical contacts:** various copper alloys, aluminum alloys, etc.
- **Electronics substrates:** various ceramics
- **Historical/ongoing programs:** AMSD, NGST, ASCOT, IRIS



Beryllium Replacement: Identify New Substitutes

- Specific to application
- New materials development
- New materials and processes developed for other uses



Beryllium Replacement: Examination of Health/Environmental Issues

- Mining and raw material extraction
- Manufacturing
- In-service
- Waste Disposal

"Cradle to Grave" Issues



Beryllium Replacement: Identify Processing Techniques and Manufacturers

- Exotic techniques lead to high cost/pound
- Potential of current technologies to re-enter the stratosphere?
- Interviews with suppliers



Beryllium Replacement: Phase I Focus

Down select to leading candidates

Properties Confirmation

- Physical testing
- Environmental testing
- Supply chain



Thank You

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