Advanced Nanostructured Powders For Cold Spray Applications

Presented By
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To
The ISCo Consortium Sponsors

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Eltron Overview

- Company history
- Approximate annual revenue is $10 million
- Government/commercial ratio is 70/30 (averaged over 5 years)
- Key Business Sectors
- Examples of commercialization success:
  - 29 patents licensed
  - Phase III Development of Hydrogen Membrane
  - Phase III Development of Hydrogen Peroxide Generator – Spin-off company Eltron Water
- 25,000 ft² research facility in Boulder, Co
- Wide range of instrumentation
- Small (0.5 kg/h) and Large (1-15 kg/h) Spray Drier Systems with Air or Inert Gas Control
- Contract Research and Development
- As of August 2011, DCAA performed an audit and approved our financial system as being compliant. DCMA concurred with the audit by DCAA.

For 30 years, Eltron has invented technologies to meet the needs of current and emerging markets.
Advanced Nanostructured Powders for Cold Spray Applications

SBIR Phase II project sponsored by the Army Research Laboratory

Topic A08-068 - Cold Spray Nanostructured Powders

Funding to date: DOD SBIR Phase I and II (Army)

Currently TRL-6 & MRL-4

Spray drying is a well-established, scalable technology used widely in food and catalyst industries.
**Project Summary:**
- **Phase I (Proof of Concept)**
  - Deliverable: Produced 3 powder compositions for the Army Research Laboratory
- **Phase II (Scale-up to 10 lb/day) - Current**
  - Produce 7 powder compositions for cold spray at ARL
  - Determine probabilistic techno-economics
    - P10/P50/P90
    - Powder costs at current and future scale
  - **Technical:**
    - Develop densification treatment
    - Characterize agglomerates
  - **Voice of Customer (VoC):**
    - Interest in Al alloys
    - Powder flowability
    - Optimal particle size distribution
- **Phase III (Scale-up to 100 lb/day): Need funding**
  - Update techno-economics
  - **Technical:** Drive development plan based on tornado plot prioritization. Key variables include:
    - Nanoparticle costs
    - Nitrogen costs

**Top Priorities / Issues:**

**Techno Economics**
- Tornado (P90, P50, P10) drives plan focus
- Determine powder costs for 100 lb/day system

**Technology & IP**
- By end of Phase II, 10 powder compositions will have been produced
- **IP:**
  - Metallic binder
  - Densification treatment
- Produce full batch using low-cost, secondary method.
- Quantify powder costs from secondary method, anticipate $20/lb.

**Partners**
- Development Partner
- Cold spray - ARL or contract spraying
- Powder toll manufacturer - Phase III
- End-user

**Key Item Time Line**

- **11/2012**
  - First batch sprayed at ARL
- **12/2013**
  - End of Phase II

**By end of Phase II, 7 of Eltron’s agglomerate batches will have been cold sprayed by ARL.**
**Technical Solution**

**Nanostructured Agglomerates**

- Benefits of Eltron’s Agglomeration Process
  - Scalability
  - Applicable to any nanoparticle composition
  - Control of oxide levels
  - Control of agglomerate particle size distribution
  - Nano-phase blending

**Superior Properties of Nanostructured Coatings:**

- Superior resistance to localized corrosion
- Increased fatigue and erosive wear resistance
- Higher hardness, toughness and strength
- Increased lifetime and durability

Nanostructured agglomerates will be used to produce nanostructured coatings with superior properties.
By end of Phase II: 7 compositions will be cold sprayed at Army Research Laboratory.
Value Proposition

- Benefits of Cold Spray
- Penetrating the “shock wave”
- Achievable Figures of Merit
  - 2X increase in abrasion resistance
  - 2X increase in hardness
  - 4-9X increase in strength
- Unique features of the technology:
  - Scalability
  - Metal binder*
  - Densification treatment*
  - Nano-phase blend*
- Invention disclosure in process

Nanostructured coatings are up to 9X stronger than coatings using conventional powders.
Applications

- Customers:
  - Cold Spray
  - Thermal Spray
  - Powder Metallurgy

- Industries:
  - Aerospace
  - Architecture
  - Marine
  - Military
  - Automobile
  - Consumer Products
  - Medical

- Coating Applications:
  - Corrosion Resistance
  - Wear Resistance
  - Antimicrobial
  - Electrically Conductive
  - Part Repair
  - Rapid Prototyping
  - Reactive Materials

Nanostructured coatings have applications in a wide range of industries.
Value Chain

- Corrosion Resistant Coating Value Chain Example

  - Nanoparticle Production → Agglomerate Production → Cold Spray Application → Finished Parts

- Potential Customer Quotes
- Competition:
  - Cryo-milling
  - High energy milling
  - Liquid particle acceleration

Eltron’s process offers reduced cost and scalability.
### Technology Roadmap

- **End of project: TRL-6 & MRL-4**

<table>
<thead>
<tr>
<th>Develop Agglomeration Technology</th>
<th>Phase II</th>
<th>Develop Nano-phase Blend</th>
<th>Develop Anti-bacterial Composition</th>
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<tbody>
<tr>
<td>Agglomerate Production</td>
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<td>Spray Nano-phase Blend</td>
<td>Spray Anti-bacterial</td>
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<td>Cold Spray</td>
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<td>Repair Tests</td>
<td>Prototypes of Nano-phase Blend Alloy</td>
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<td>Repair Aircraft Components</td>
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<td>Develop Certification Methods</td>
<td>Lifetime &amp; Flight Testing</td>
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<td>Rapid Manufacturing</td>
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<tr>
<td>Time</td>
<td>2013</td>
<td>2014</td>
<td>2015</td>
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With quick scale-up, nanostructured coatings could be in use within 5 years.
Partnering Interests

- Open to broad spectrum of partnering:
  - Licensing through Joint Development
  - Phase III 100 lb/day System - $2 Million
- Alternative development plans

<table>
<thead>
<tr>
<th>Phase III Activities</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<td>Spray Drying - Arrange toll producer</td>
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<td>Produce 100 lb/day agglomerates</td>
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<td>Densify powder at 100 lb/day</td>
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<td>Cold spray agglomerates to verify coating properties</td>
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Next Steps

- Cold spray at ARL
- Techno-economic Analysis
- Involvement in Phase II
  - Help define market of interest
  - Project metrics
- Phase III starting as early as January, 2014.
- Samples for testing at your facility