Eltron Research & Development

Advanced Nanostructured Powders For Cold Spray Applications

Presented By

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Eltron Research & Development

To

The ISCo Consortium Sponsors

September 20, 2012

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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 ft^2 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.

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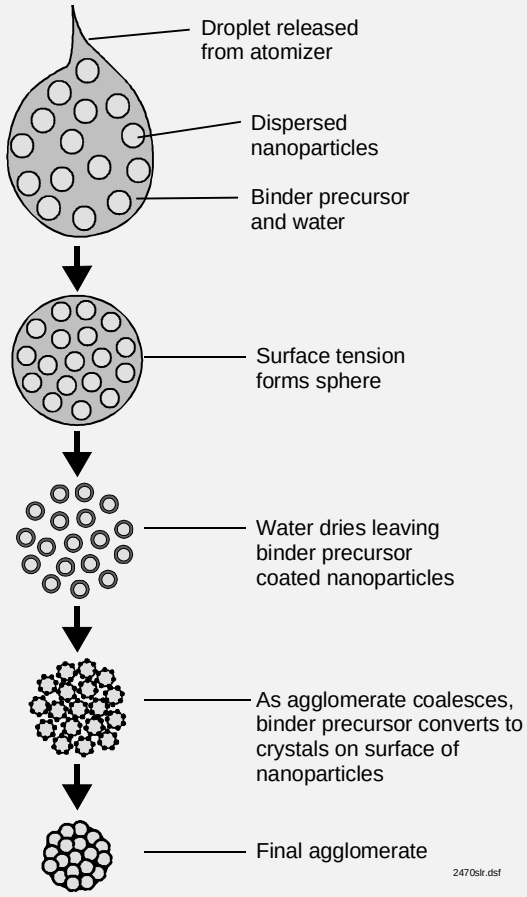
Project Description

- 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.

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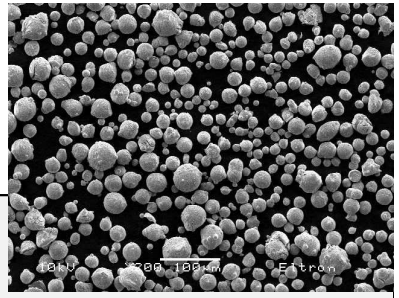
Project Snap-Shot



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.

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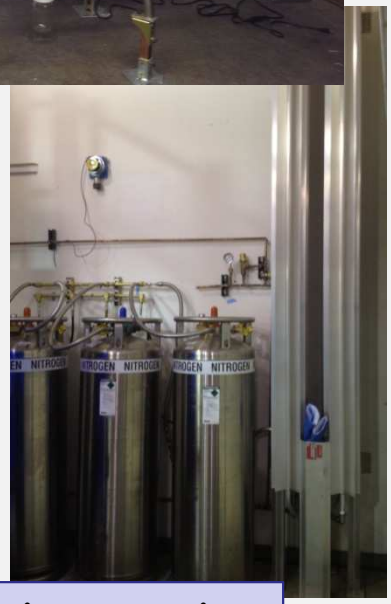
Technical Solution

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.

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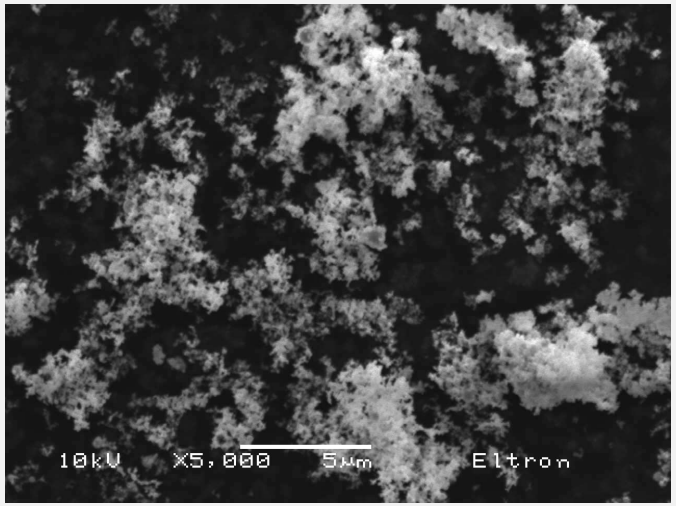
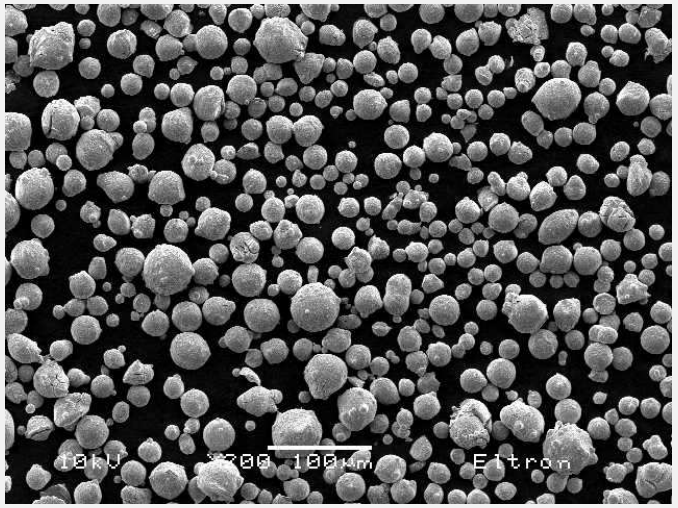
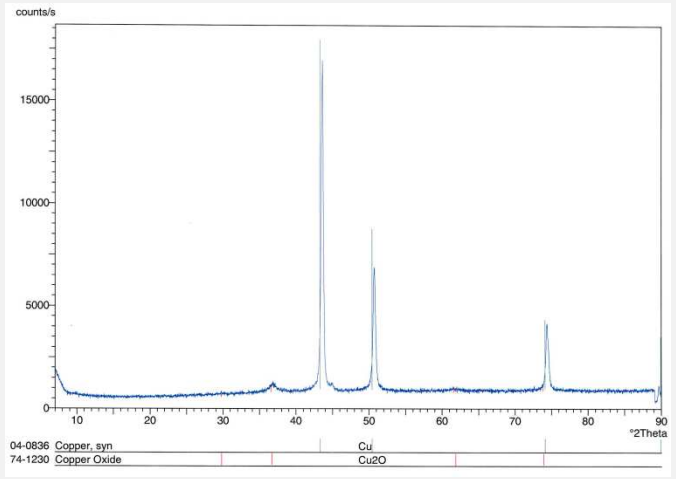
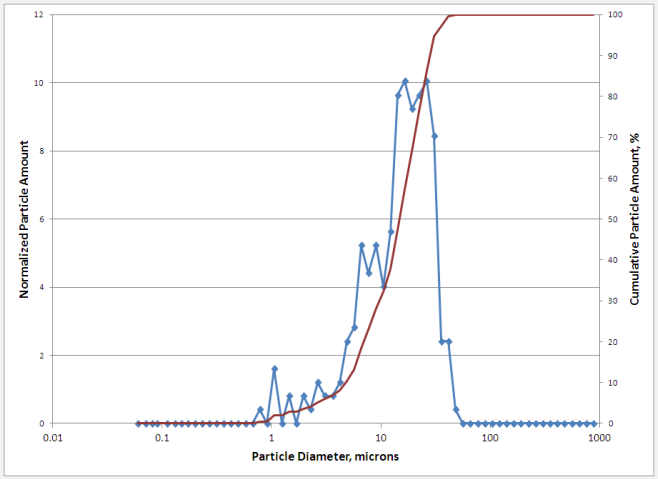
Progress to Date









By end of Phase II: 7 compositions will be cold sprayed at Army Research Laboratory.

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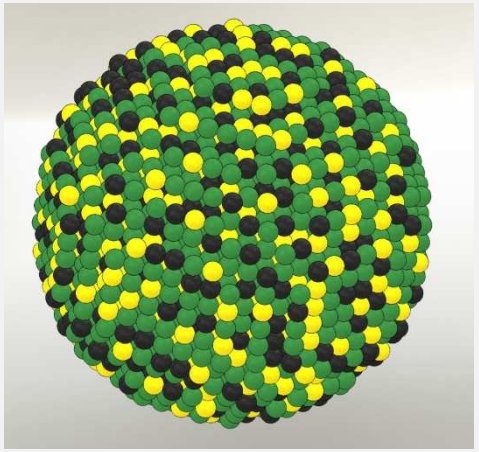
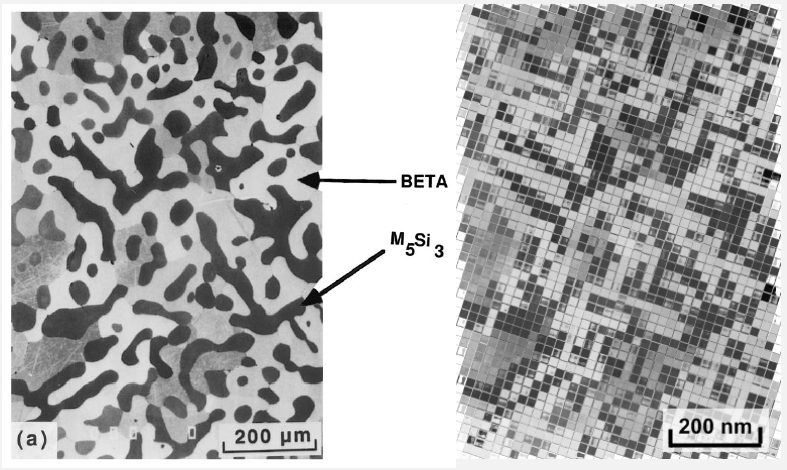
Value Proposition

- 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.

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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.

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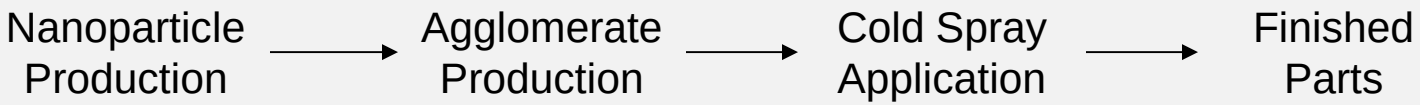
Value Chain

- Corrosion Resistant Coating Value Chain Example



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

Eltron's process offers reduced cost and scalability.

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Technology Roadmap

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

Develop Agglomeration Technology	Phase II			Develop Nano-phase Blend			Develop Anti-bacterial Composition					
Agglomerate Production			Phase III			Spray Nano-phase Blend				Spray Anti-bacterial		
Cold Spray				Repair Tests			Prototypes of Nano-phase Blend Alloy				Anti-bacterial Coatings	
Repair Aircraft Components					Develop Certification Methods	Lifetime & Flight Testing			Part Repair			
Rapid Manufaturing										Manufacture Nano-phase Blend Alloy Parts		
Time	**2013**		**2014**		**2015**		**2016**			**2017**		

With quick scale-up, nanostructured coatings could be in use within 5 years.

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Partnering Interests

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

Phase III Activities	1	2	3	4	5	6
Spray Drying - Arrange toll producer						
Produce 100 lb/day agglomerates						
Densification treatment - Arrange toll producer						
Densify powder at 100 lb/day						
Cold spray agglomerates to verify coating properties						

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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