Solidica’s Experience with Industry / University Cooperative Research Centers

January 8, 2009
Presentation Outline

- About Solidica
- About Our Partners
- Partnering with Universities
- How We Learned About the I/U CRC
- Business Case for Joining an I/U CRC
- Solidica’s I/UCRC Experience to Date
- How Can We Improve?
  - Solidica
  - Universities
  - NSF
About Solidica

- Founded in 1999, located in Ann Arbor, MI
- Proprietary direct metal additive manufacturing technology: ultrasonic consolidation
- Advanced wireless sensors and mesh networks
Ultrasonic Layered Manufacturing

- Initial clamp force collapses asperities
- Ultrasonic energy is coupled through the stack into the anvil
- The interface experiences simultaneous fracture of the oxide films
- Parent material welds across the interface
- Weld zone grows to maximum area
Ultrasonic Consolidation

Ultrasonic energy is used to create a solid-state bond between two pieces of metal – “metal tape lay up” like process

True metallurgical bond
8 layers Al, 100x
Temperature Changes

- In ultrasonic joining, peak temperatures rarely exceed \(0.5T_{\text{melt}}\)
- Very small affected volume
- Local formation of nano-grains
Formation Machine
Product Focus: Metal Intermetallic Laminate Composites

- Working with Army, Marines
- Production of hybrid metal-intermetallic composite laminates
  - Blast applications
- UC process holds promise for low cost production
  - Low temperature laminate production
  - React in solid state to produce intermetallic
- Additional UC enabled technologies can be implemented
  - Fiber MMC
  - Embedded sensors, etc.

UC bonded Al-Ti laminate
Key Partners & Customers

GM
freescale
Delphi
Ford
LG
EWI
ZigBee™
Alliance
Boeing
Kodak
Raytheon
John Deere
Navsea
Utah State University
Alcoa
University of Cambridge
The Ohio State University
NSF
Clemson University
Lockheed Martin
Virginia Commonwealth University
CPF
Center for Precision Forming
Medtronic
NAVSEA
Medtronic
DARPA
Raytheon Systems Company
adidas
Life’s Good
We never forget who we’re working for™
Partnering with Universities

- Solidica Management are Comfortable Collaborators
  - Special Partnership with EWI
  - Founder: Ph.D. Ford Research
  - President: Ph.D. Delphi Licensing Exec and NCMS
  - Engineering Manager: Office of Naval Research and NCMS

- Appreciate the Value and the Role of the University
  - Good Engineering Science
  - High Standards for Research
  - Educate the Nation’s Leaders

- Don’t stray from the University’s Role
  - Cooperate with publication

- Include Budget, Schedule and Deliverables in Plans
How We Learned About I/U CRC

- VCU - Muammer Koç called our president
  - They knew each other from Prof. Koç’s prior consulting with Solidica
  - I/U CRC “Dear Colleague” letter offered opportunity to compete for funding.

- OSU – EWI called us
  - EWI aware of Solidica needs via continuing dialog. EWI advised us of their work with Prof. Dapino at OSU Smart Vehicles Center

- Observations:
  - University-industry dialog relevant for Engineering Science.
  - Trust already established. Strangers do not collaborate.
Select Appropriate Research Topics

Avoid Intellectual Property issues. Choose topics that focus on university capabilities. Both universities emphasized I/UCRC as introduction to longer term relationship.

- Mechanical Testing of Laminates (OSU, Dapino)
  - Develop consistent and quantitative methods for testing bond quality in Ultrasonic Consolidation (UC), with the further objective of improving UC process performance.

- Forming Laminates (VCU, Koç)
  - Develop knowledge of the forming behavior of ultrasonically consolidated titanium-aluminum laminates;
  - Develop property/formability relationships for design and fabrication
Business Case for Joining an I/U CRC

- NSF accepted proposals to cover the I/U CRC membership fee, less $5,000, for one year ($40,000 - $5,000 ~$35,000)

- Solidica calculated that our cost to participate in each center was ~$15,000/year
  - Materials (titanium)
  - Sample fabrication and prep time, 3rd party waterjet cutting
  - Meeting time and travel

- We could afford ~$15,000, but not $55,000
  - Decision at the company director level
  - Solidica drafted the research plan
  - Time, budget, schedule emphasized
  - Superb university response
Solidica Experience to Date

- Quick response from NSF. June starts.
- Very quick first round response from VCU. Analysis by October!!
- Partnering on another proposal with each center.
- Solidica submitted proposal for second year funding.
Tensile Test Results - VCU
Bulge Test Results - VCU

1-bilayer

3-bilayer

5-bilayer

Room  100°C  200°C
Tensile flow curves – VCU
rolling direction, temp, # layers

Dotted curve means the pulling direction is parallel to the rolling direction.
How Can We Improve?

Solidica

- Make partners part of the business plan – each appropriately engaged
- Develop / improve trusted relationships – requires real work
  - University Partner gets the full briefing, even though the NSF program is pre competitive
- Appreciate the university. Don’t stray from the university’s role. Cooperate with scholarly researchers who must publish
- Include Time, Budget, Schedule and Deliverables in Plans
How Can We Improve?

NSF / Universities

- For Engineering Science, continue to reward universities for engaging with industry where appropriate.
  - I/U CRC works well. STTR works well
- Continue to engage universities with other universities
- I/U CRC program seems to be on a very low budget (for the university)
- Without diminishing either requirement, help universities juggle the dual requirements for:
  - Publishing scholarly research
  - Collaborating with commercial companies
Thank You!

SOLIDICA