Advanced Onsite Fabrication of Continuous Large-Scale Structures

Corrie I. Nichol, Ph.D.

AMM Workshop

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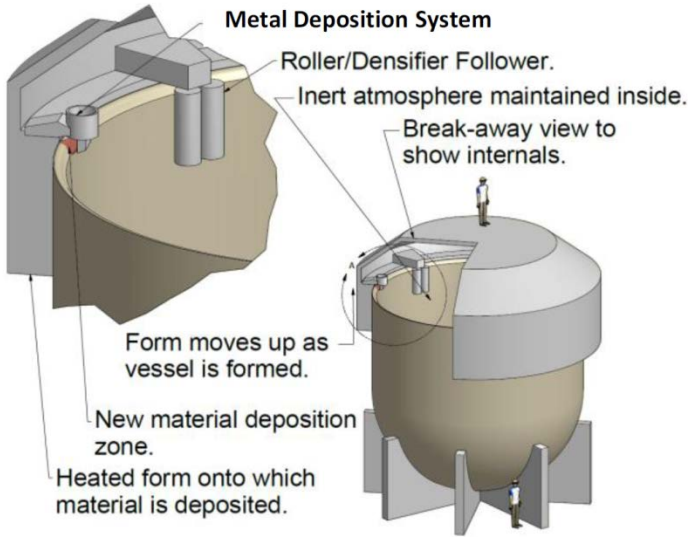

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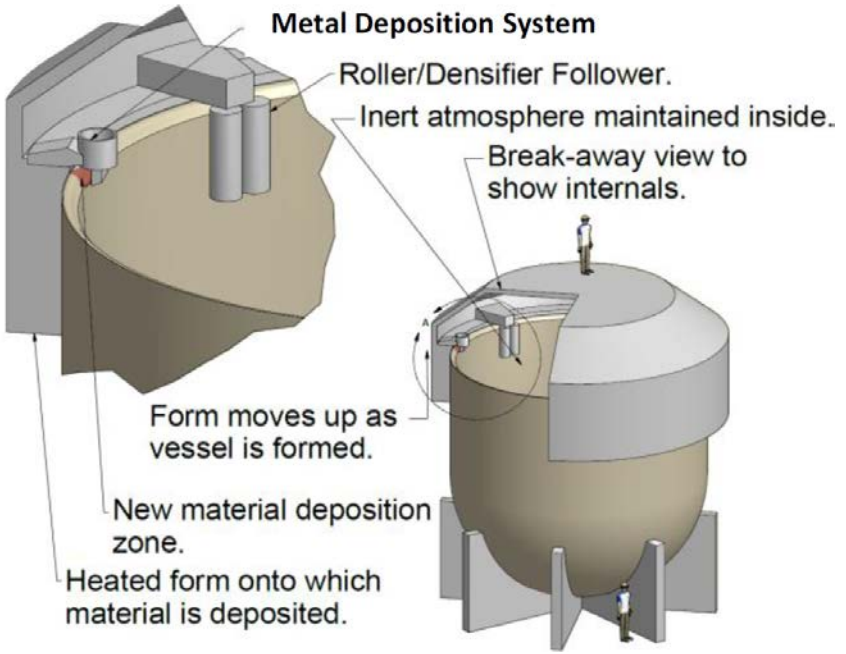
Concept Overview

- Cross between 3-D printer and Concrete Slip-Forming
- Structure built on-site from small format raw materials
- Form moves up as vessel is formed
- Material is fully densified by roller follower



Potential Benefits

- Potential multi-material composite construction, multi stress-state end product.
  - Corrosion resistant cladding, high strength steel alloy interior.
  - Residual compressive stresses to reduce corrosion cracking.
- Material transported to site in small form factor. (No component size site limitations.)
  - Site access to large navigable water-ways for component transport not required.
- Welds largely eliminated.
  - Residual weld stresses/weld flaws eliminated.
  - Weld inspection burden reduced.
- Domestic large vessel fabrication.
  - Ultra-heavy forging companies are no-longer in the U.S.

Year 1 Accomplishments

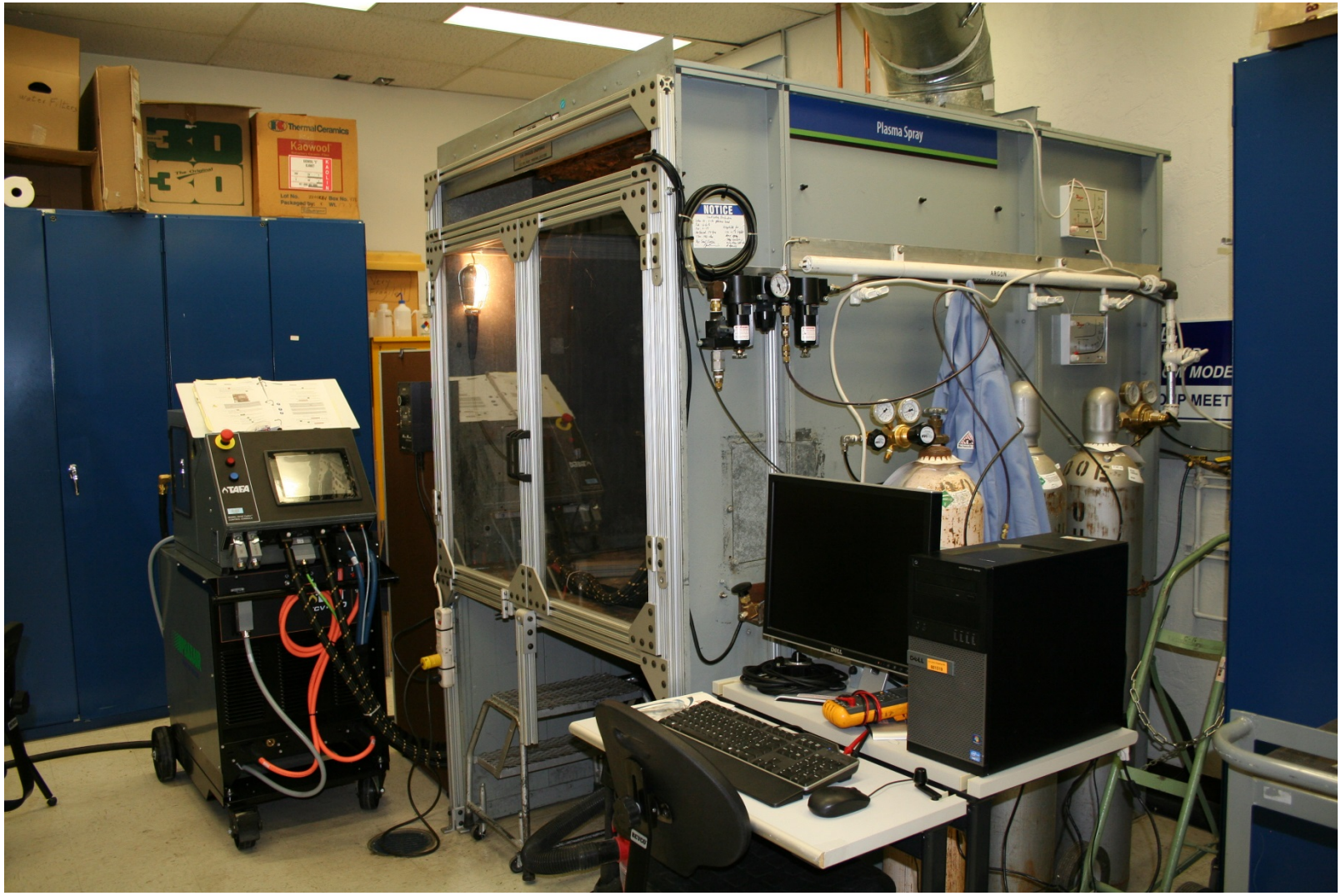
- Spray forming process modeling
- Surrogate process selection
  - Commercially available
  - Bench scale
- Initial system setup
- Initial testing and material
- NDE for in-process control and inspection

Minimum Energy for Spray Forming Process

Material:	Stainless Steel	
Deposition Rate:	0.50	kg/min
Heat to melt material:	8.33	kW
Gas for Material Transport:		
Argon	14.16	kW
Nitrogen	28.28	kW

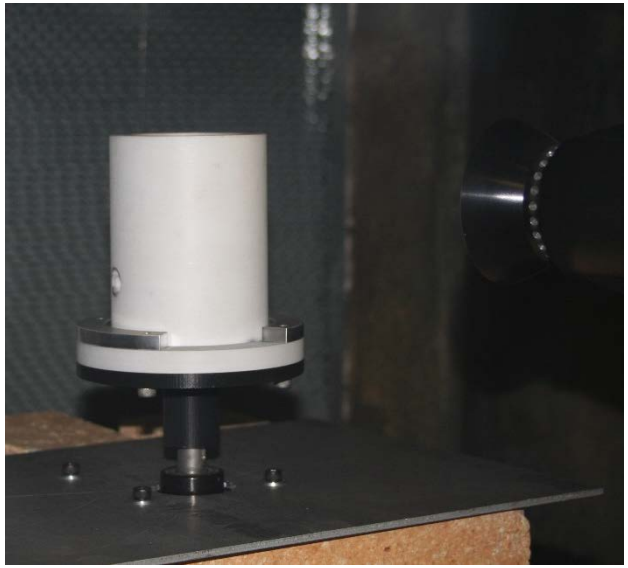
- Simplistic analysis
- Process losses
  - Heat loss unaccounted
  - Process inefficiencies
- Recycle energy
- Bench scale process

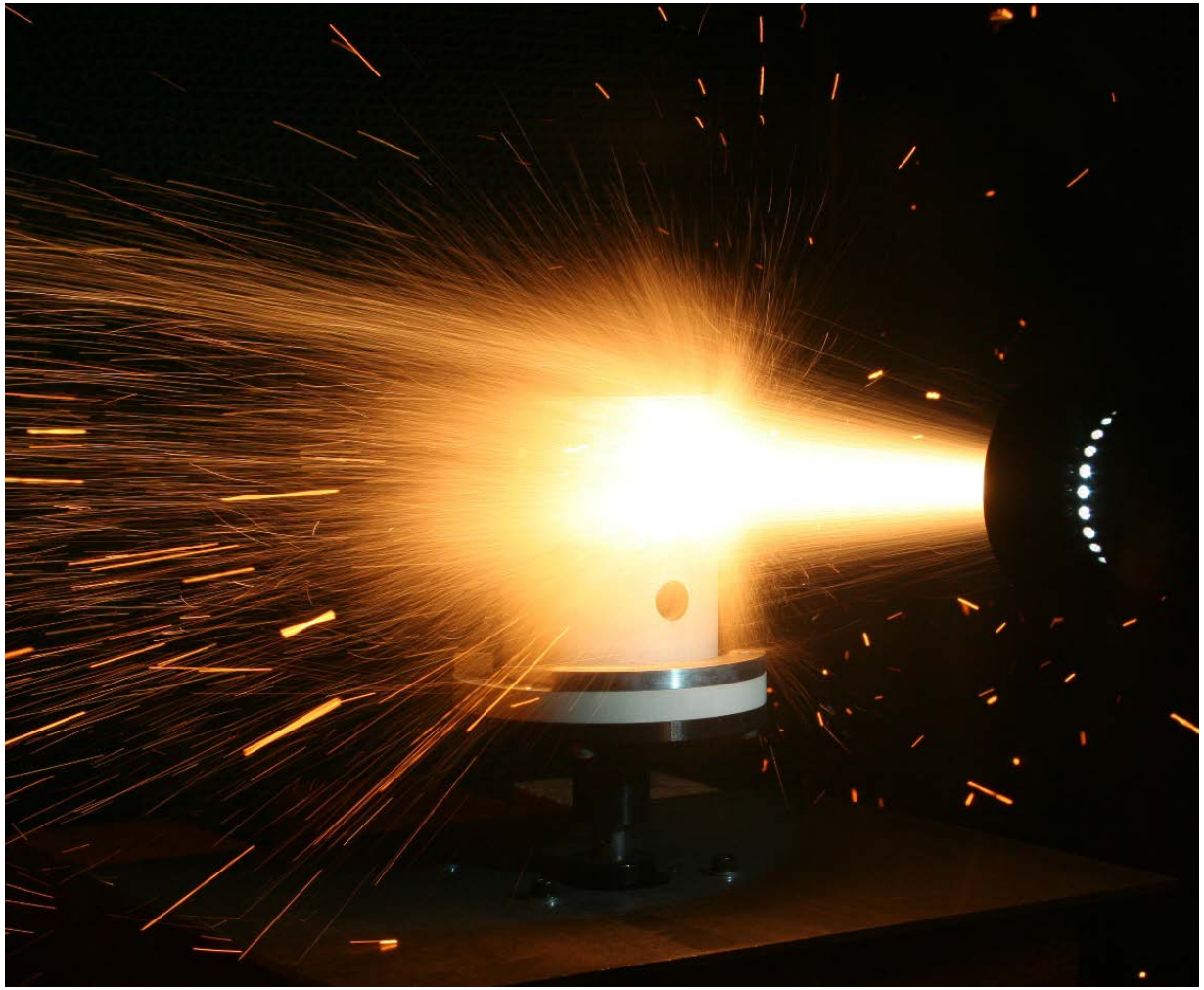
System Overview



Spray Booth Internal Layout

Initial Spray Test





Initial Material Produced

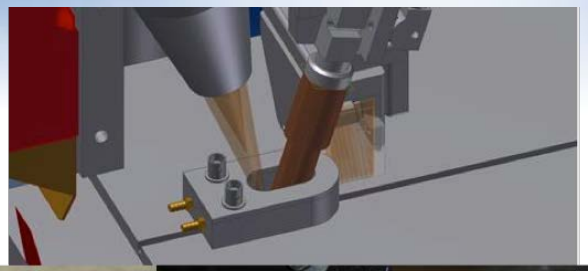
- High porosity
- High inclusion
- Brittle
- Shape follows ceramic form
- Separation due to temperature differential
- Process resolution limitations

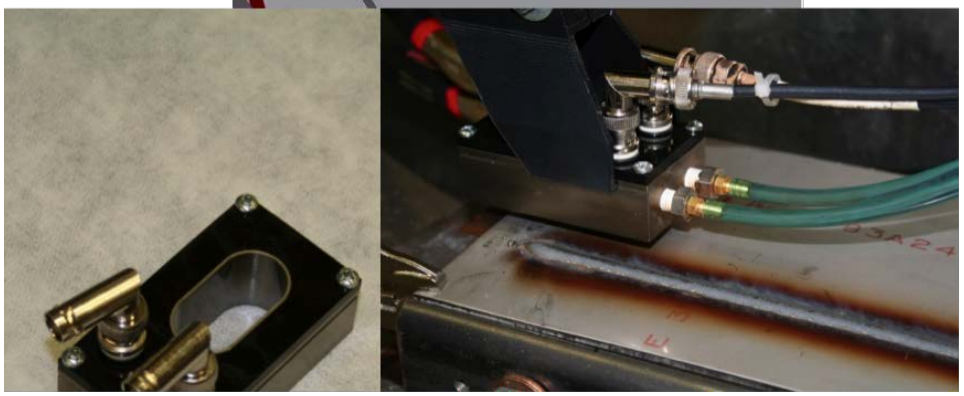
Initial NDE Research

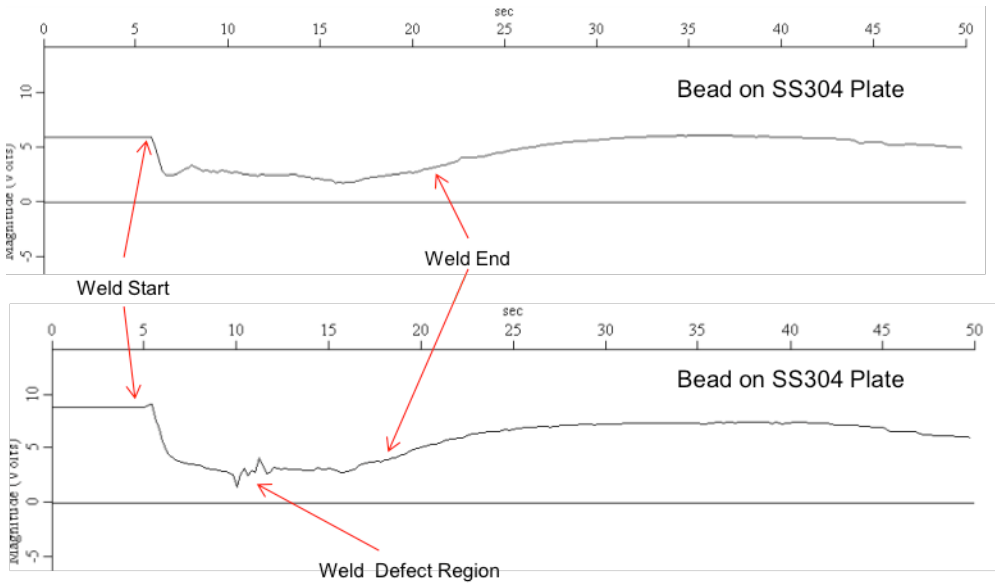
- Previous experience with high temperature NDE environments
- Comparison of current project NDE requirements vs. past projects
  - Substantially elevated temperature
  - Potential material interactions/attenuation
- Continuing research on techniques for NDE

ET Tests on Hot Samples

- In-process inspection of Welding process
- High temperature
- Non-contact
- Probe cooled via water circulation
- Resolution of process

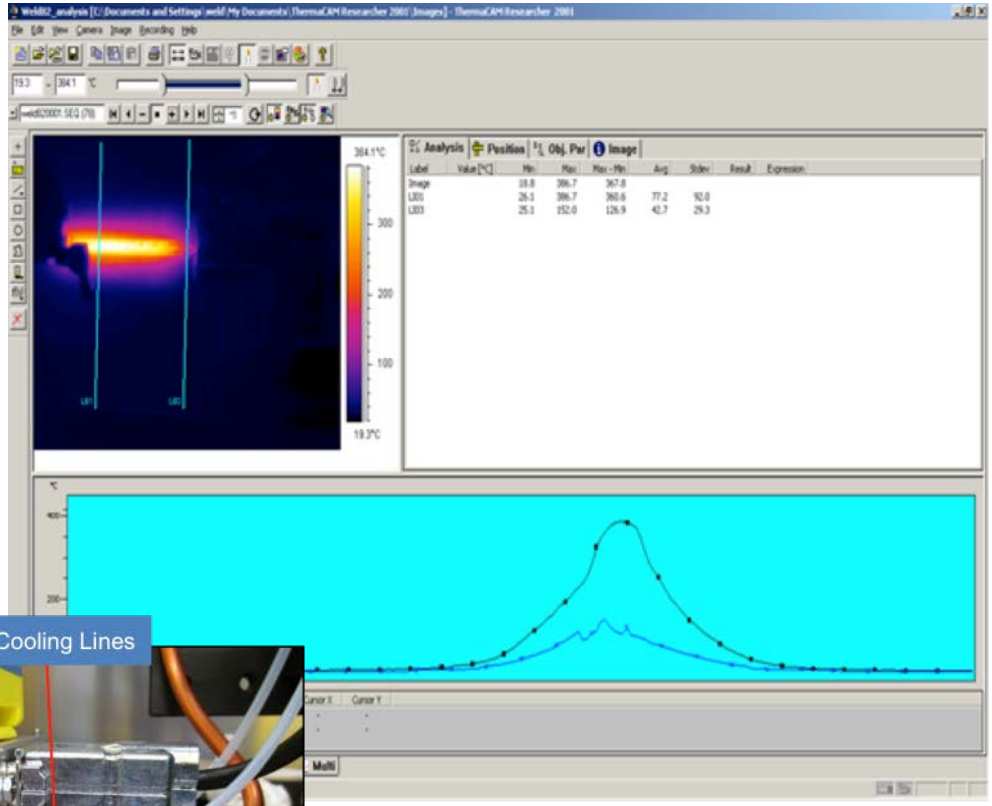


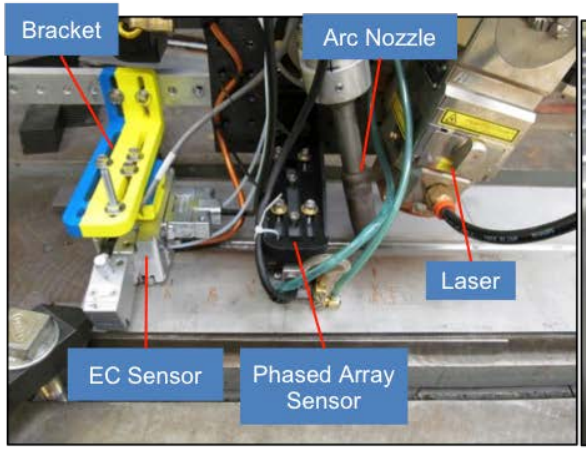




Temperature and NDE

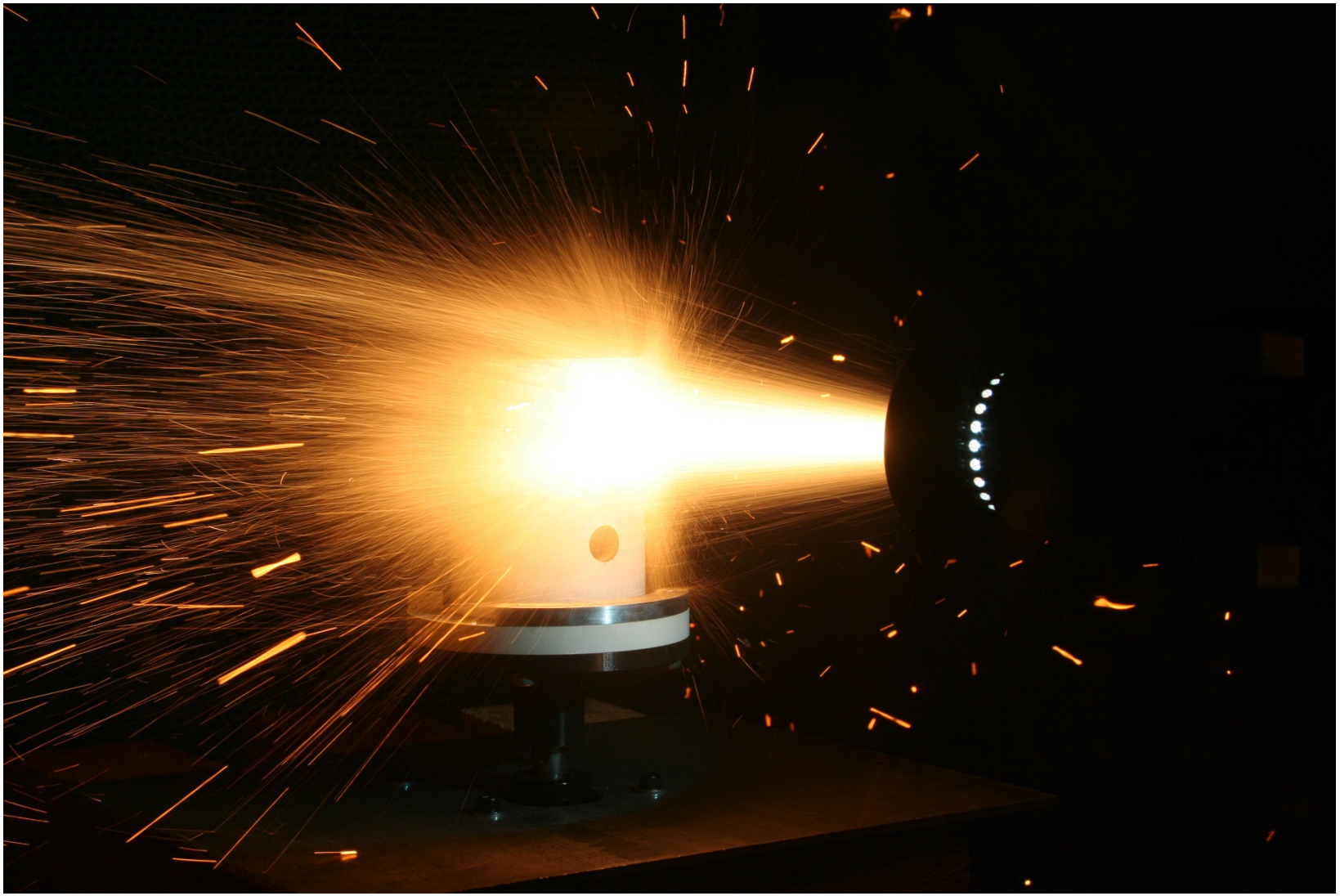
- NDE methods from previous research
- Temperature challenges

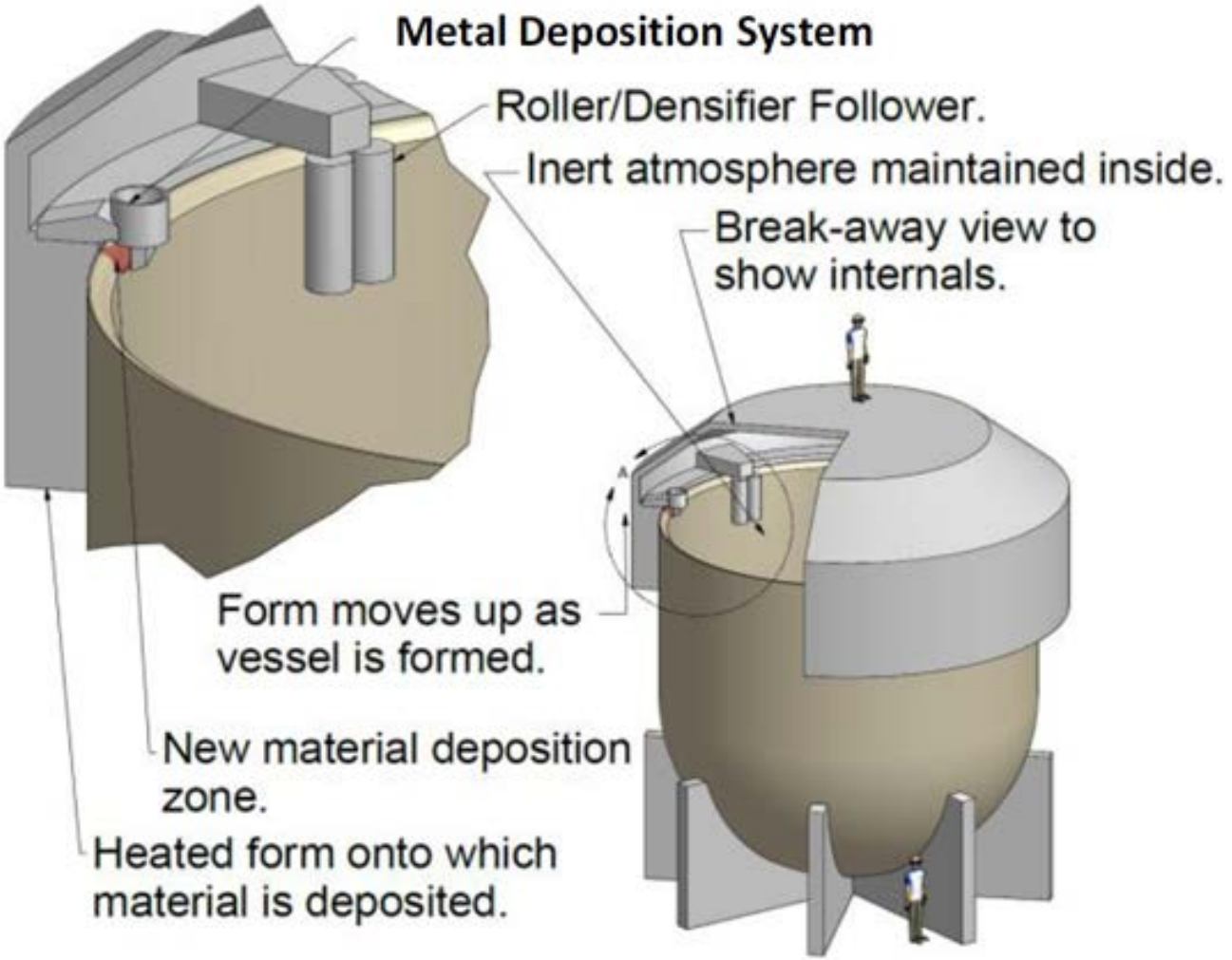




Upcoming Work

- Optimize process spray parameters
- Testing resulting materials
- NDE of material (cold, then hot)
- Investigate inert gas for arc spray system to reduce oxide inclusion




Metal Deposition System
Roller/Densifier Follower.
Inert atmosphere maintained inside.
Break-away view to show internals.
Form moves up as vessel is formed.
New material deposition zone.
Heated form onto which material is deposited.