



Blazing New Frontiers in Composite Tooling Using Reactive Additive Manufacturing

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Background

Mississippi State University's Advanced Composites Institute (ACI) is an expert in composite design, engineering, fabrication, and testing. The ACI resides in a 50,000 sq. ft. facility with large-scale capabilities, including a 50 ft oven and 40 ft. stitching robot. In partnership with Magnum Venus Products, the ACI has recently procured a unique and innovative large-scale thermoset Reactive Additive Manufacturing (RAM) 3D printer.

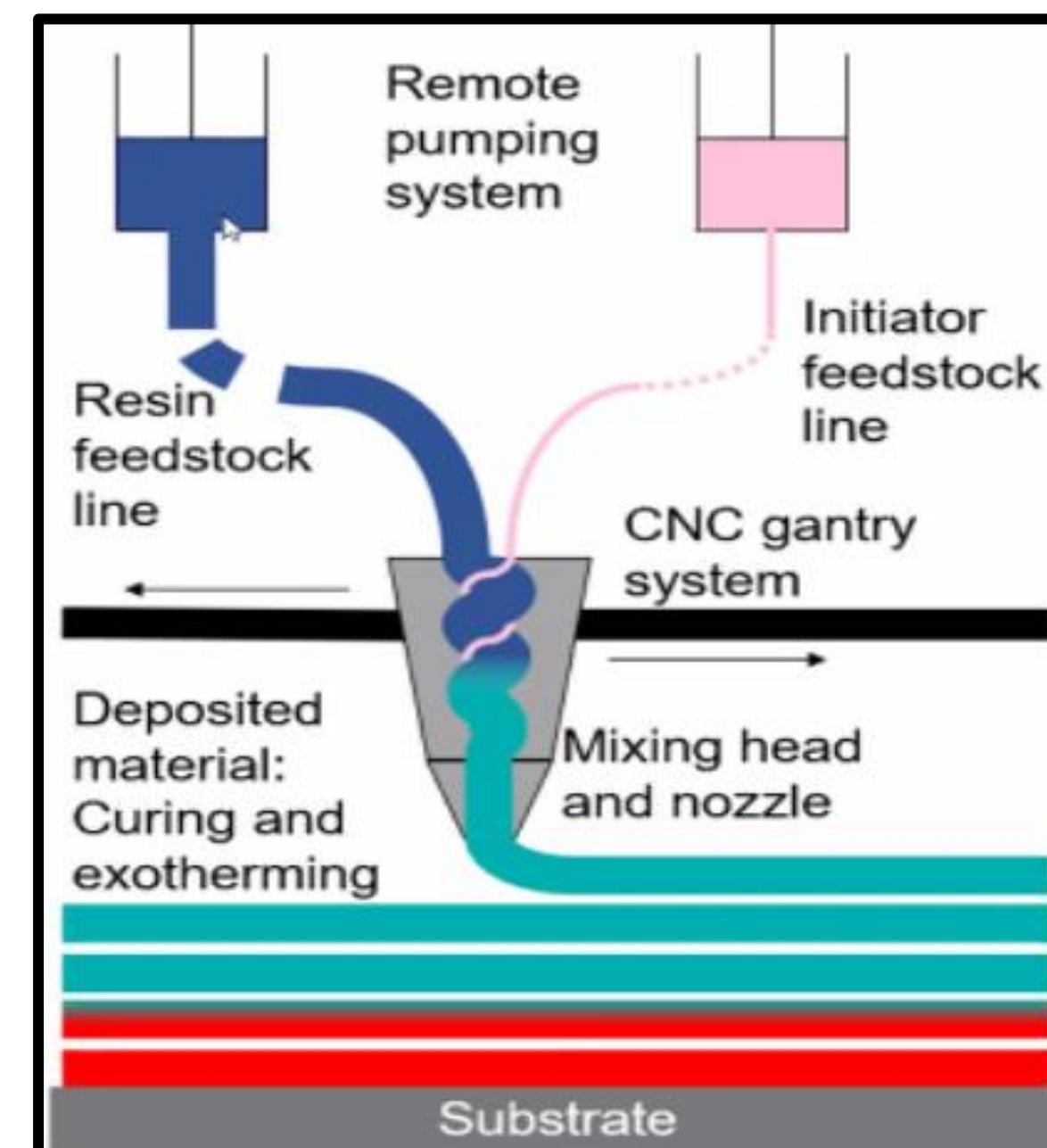
The Technology



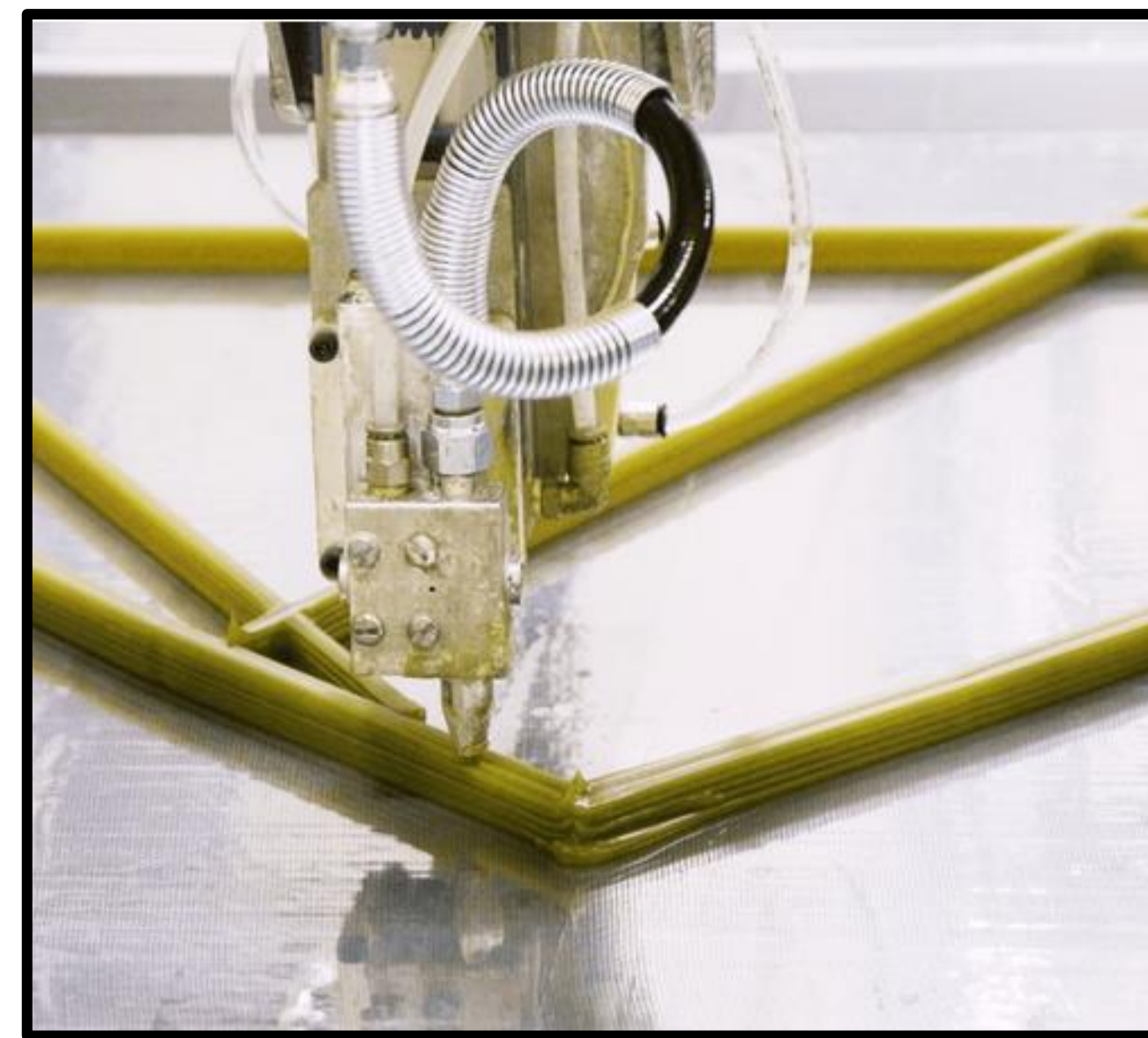
- 4'x8'x4' print bed.
- Produces "Near net" parts at a rate of 60 lb/hr.
- No heating for deposition or bed.
- Variable nozzle size.
- Flexibility to change the print bed.

MVP's RAM printer uses thermoset chemistry to cure layers together instead of fusing them together like in conventional thermoplastic printing.

- Resin and initiator are mixed and pumped through the system.
- The pumping system is metered to allow the material to deposit at a constant rate.
- The deposited material remains reactive to allow the next layer to cure.



The Materials

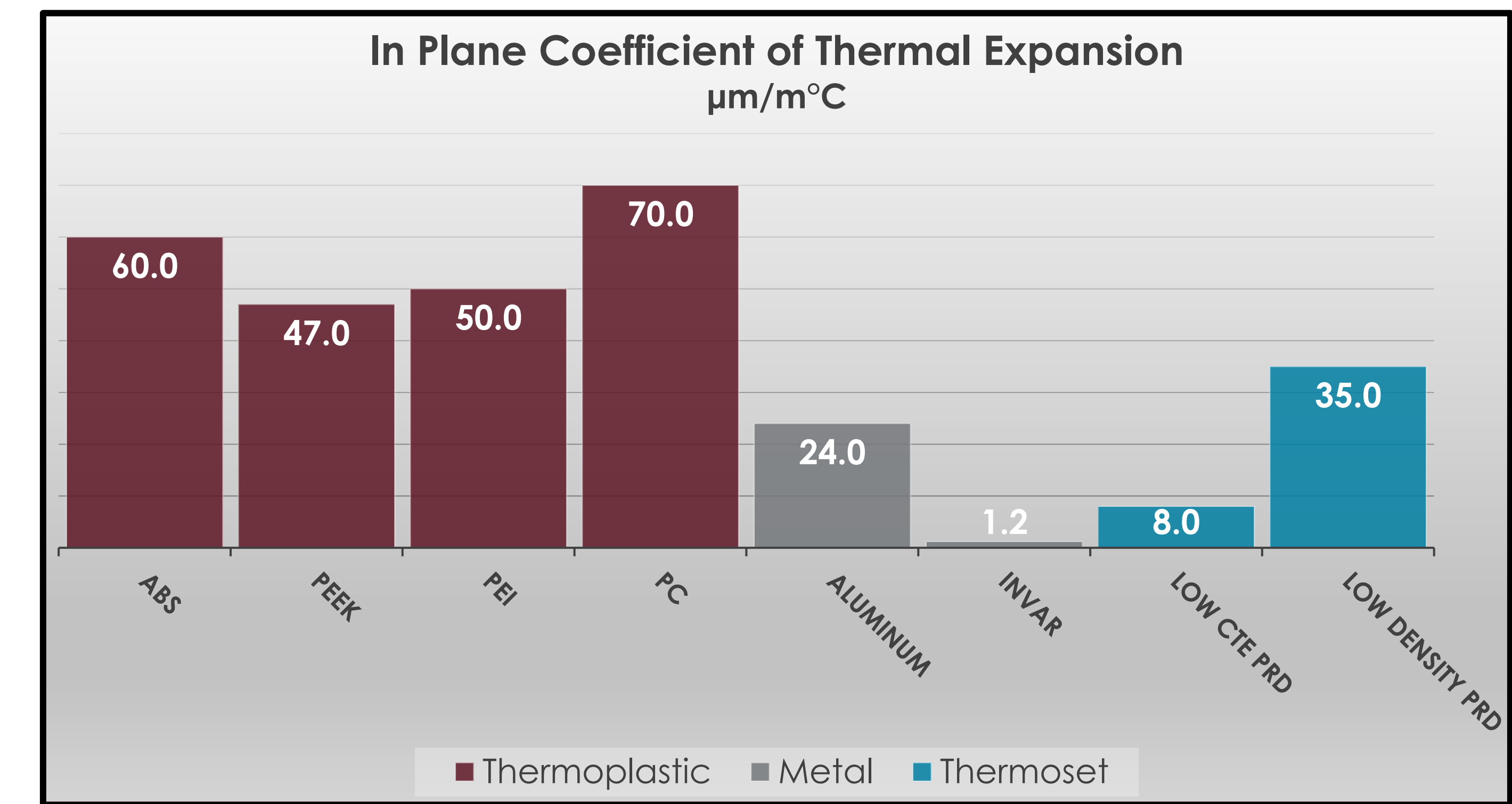


- Typically epoxy or vinyl ester resin.
- Open layer times of up to 10 days.
- Low cost.
- Room temp cure for most applications.
- Parts can be bonded together after being printed

Longer open layer time allows for the placement of sensors, plumbing, and core materials without compromising layer adhesion.

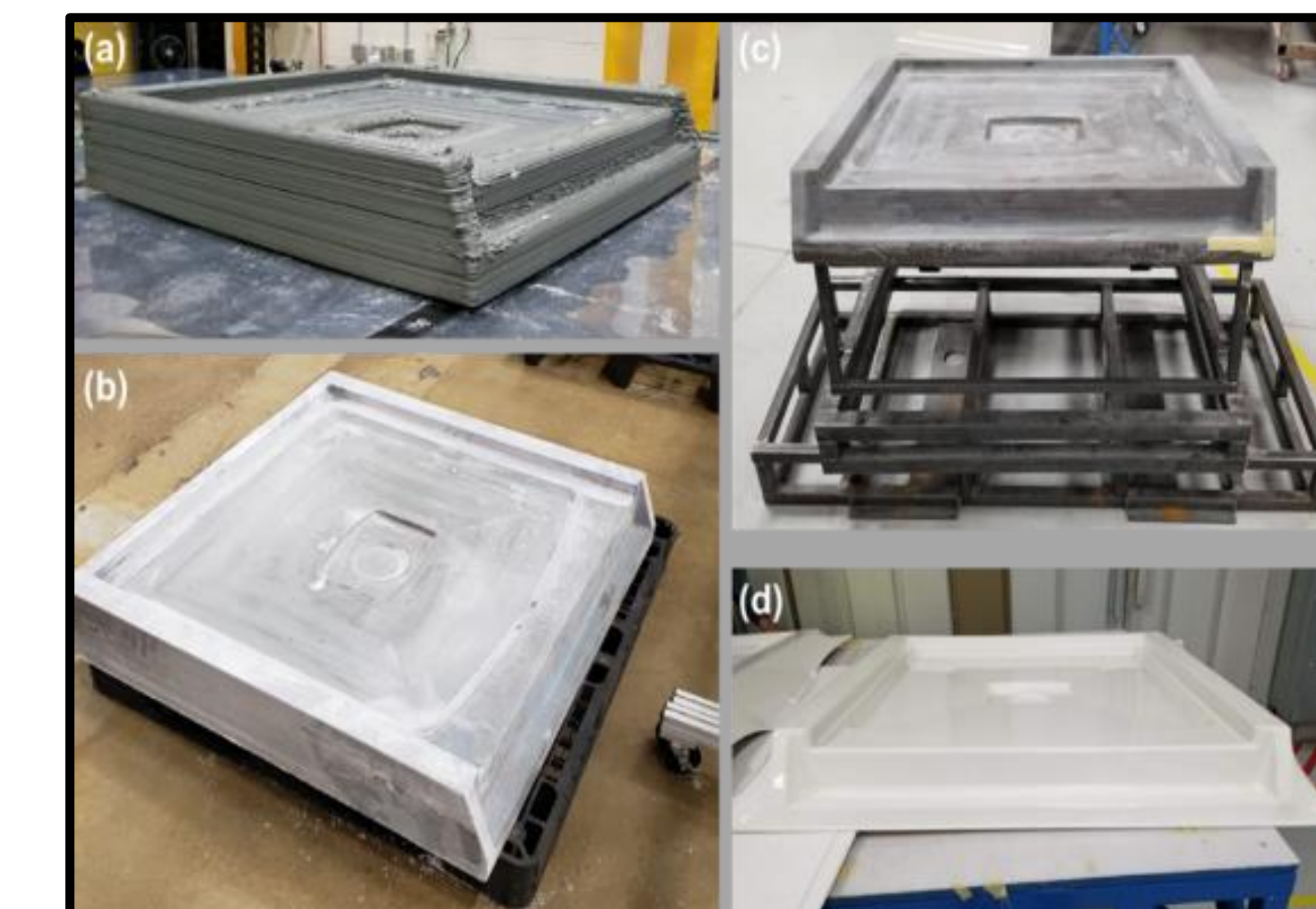
Polynt Reactive Deposition Media	General Purpose PRD	Styrene Free PRD EX1630	Low Shrink / CLTE PRD EX1632	Thermally Conductive PRD EX1633	Low Density PRD EX1631
Flexural Strength (psi)	9,400	8,030	4,437	5,300	7,200
Flexural Modulus (psi)	635,000	1,079,000	643,000	1,076,000	986,000
Tensile Strength (psi)	4,600	4,240	2,832	3,400	3,500
Tensile Modulus (psi)	581,500	1,279,000	720,000	492,000	951,000
Tensile Elongation (%)	1.0	0.4	1.7	1.3	0.5
Compressive Strength (psi)	10,100	19,100	5,668	8,600	8,500
Compressive Modulus (psi)	343,000	1,059,000	317,000	236,000	637,000
Tg(°C)	107	100	169	98	100
Tan Delta DMA	107	100	169	98	100
CLTE (0-160°C) (µm/m°C)	x = (46) y = (127) z = (176)	x = (43) y = (23) z = (249)	x = (8) y = (1) z = (83)	x = (81.5) z = (202)	x = (35) y = (37) z = (166)

Advantages



- In-plane CTE of metal with the unique advantages of conventional AM.
- Higher isotropic out-of-plane CTE performance.
- RAM requires no heated nozzle or bed, allowing 80%-99.8% electricity savings.
- Prints can be cured together, which allows parts to be made larger than the print bed volume and for the creation of 90° overhangs without support structures.
- Surface can be milled and reprinted, allowing tools to be reused and repurposed.

Applications



- Complex geometry tools.
- Quick and cost-effective prototyping and manufacturing.
- Energy conscious manufacturing.