# In-situ Reactive Printing of Aluminum Matrix Composite with Ultra-high Volume Fraction Reinforcement

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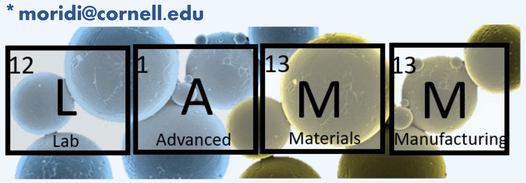


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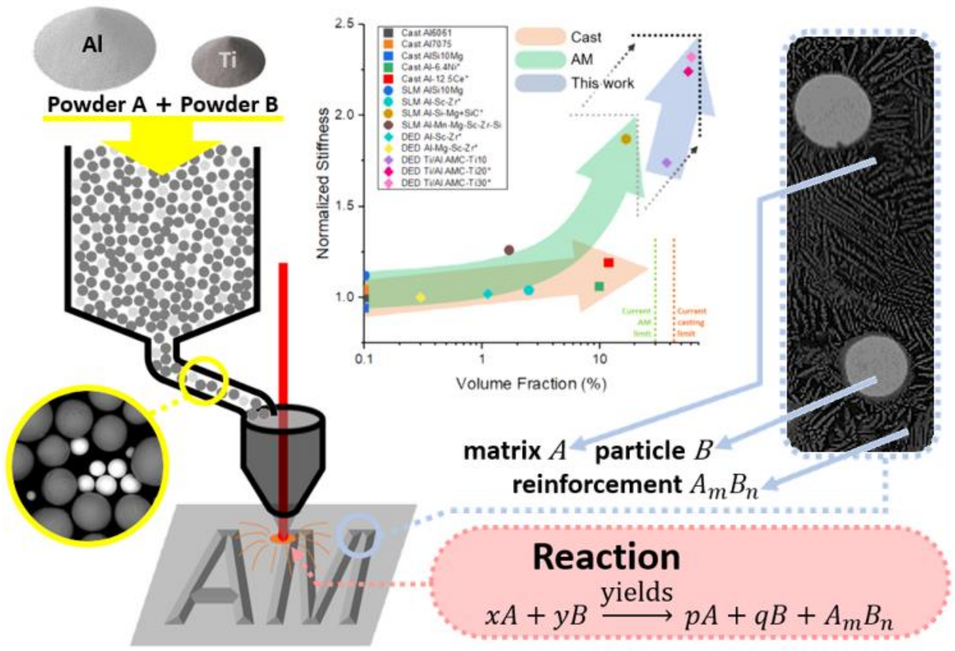
## Highlights

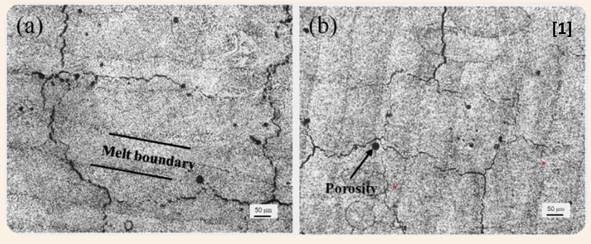
- Addition of titanium powder enhances aluminum powder's processibility
- Better laser absorption and in-situ reactions contribute to better processibility
- Reactive printing yields ultra-high volume fraction reinforcement in aluminum
- Enhanced reinforcement volume fraction results in significant stiffness improvement




## In-situ Reactive Printing (IRP)

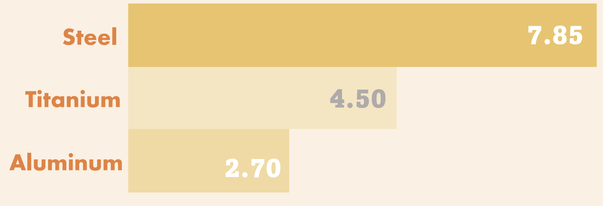
A novel processing method based on current additive manufacturing processes, aiming to fabricate metal matrix composite from feedstock of elemental powder mix. Printability improvement as well as property enhancements root from an intermetallic phase formed via reactions in matrix material during printing.

## Motivations




Solidification cracking in AM Al6061

- Scarcity of AM-friendly aluminum alloy/composite material
- Severe cracking problem caused by aluminum's large freezing range
- Lack of lightweight structural material
- Lack of high stiffness aluminum-based material
- Reinforcement volume fraction ceiling in production of conventional AMC as well as latest AM AMC



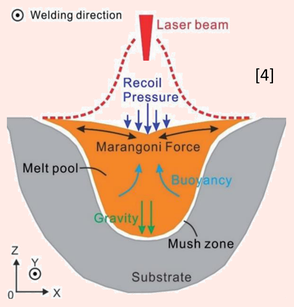

Structural Material Density (g/cm$^3$)

## Additive Manufacturing + Synergy of Ti & Al

isolated particle: Ti 0.40, Al 0.056

particle & substrate: Ti 0.64, Al 0.22 [2]

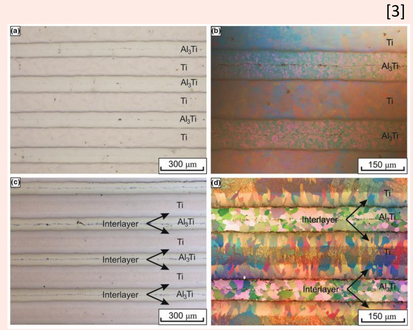
Better laser absorption



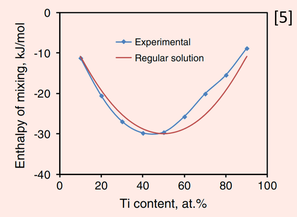

[4]

Better mixing

[3]




Predictable intermetallic formation

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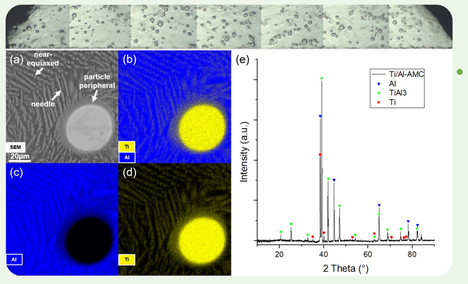
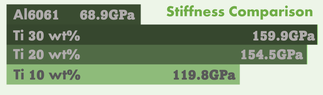
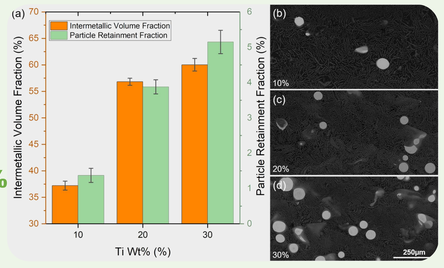
## Results



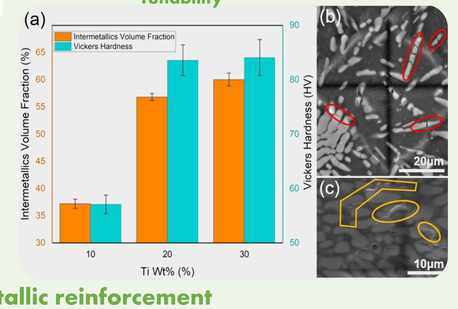

- Near fully-dense prints
- Refined and dispersed reinforcement
- Expected reinforcement composition




- Tunable intermetallic volume fraction
- Highest volume fraction exceeds 60%




Mechanical Tunability ⇄ Compositional Tunability




- Strength from reinforcements
- Ductility from matrix material
- Ultra-high volume fraction of intermetallic reinforcement

**References:**

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[4] Progress on Experimental Study of Melt Pool Flow Dynamics in Laser Material Processing, http://dx.doi.org/10.5772/intechopen.97205

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