

Solid-State Powder Generation for Circular Economy in Additive Manufacturing

Ping Guo

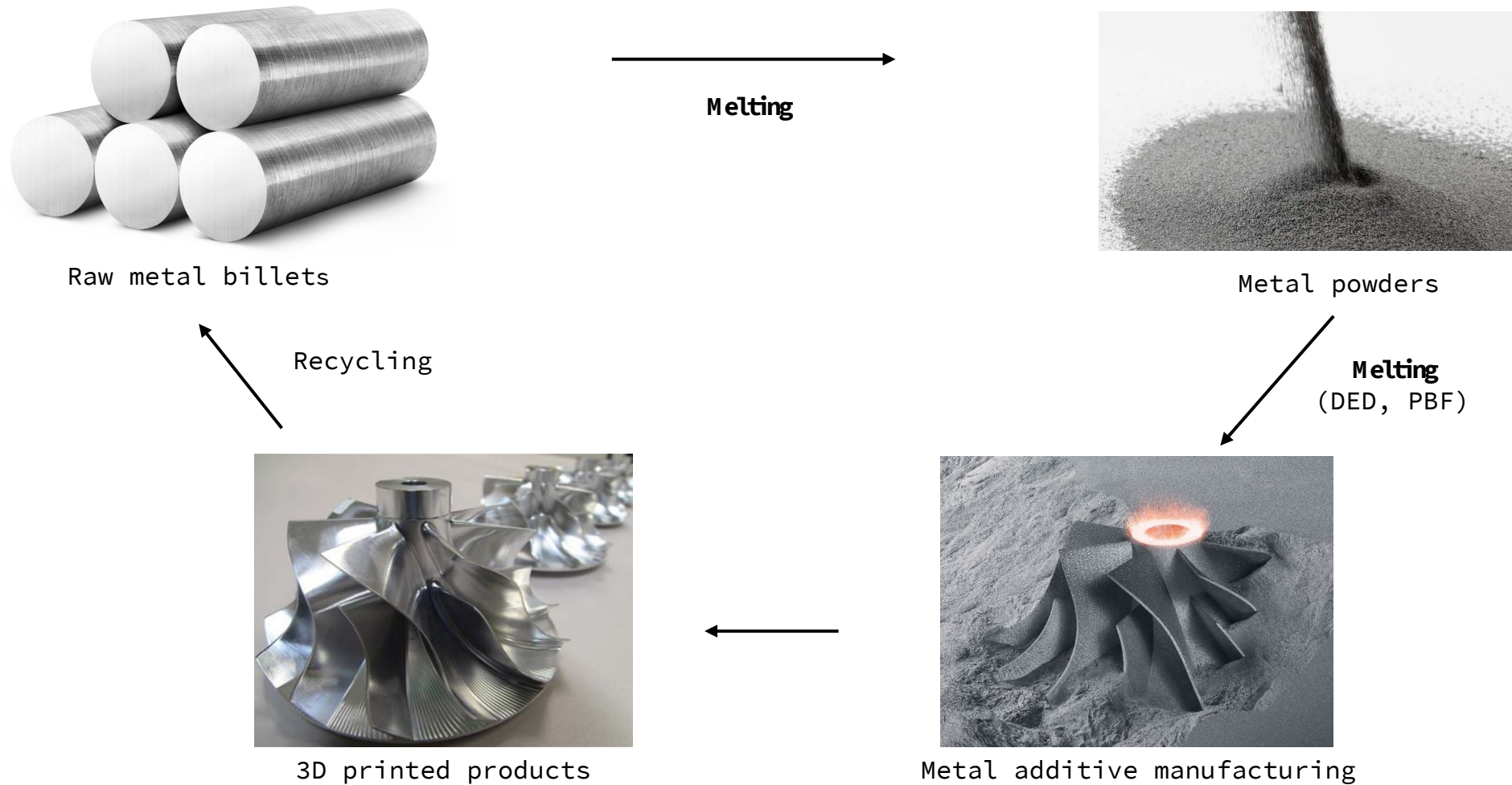
Assistant Professor
Department of Mechanical Engineering
Northwestern University

Email: ping.guo@northwestern.edu

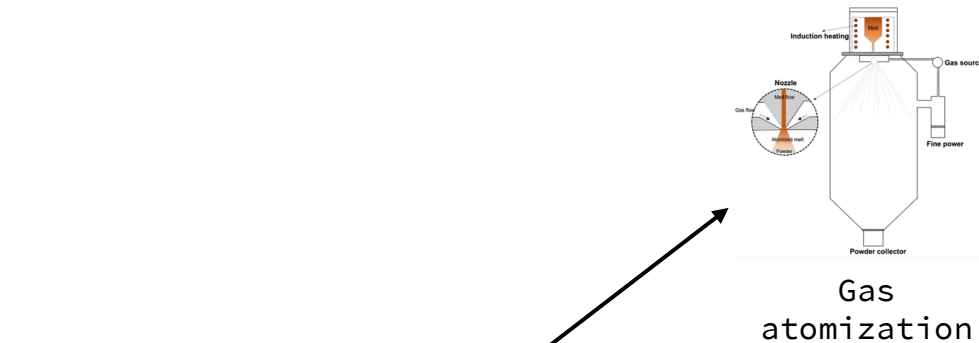
Website: <https://pingguo.mech.northwestern.edu/>

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Circular Additive Manufacturing Economy and Opportunities



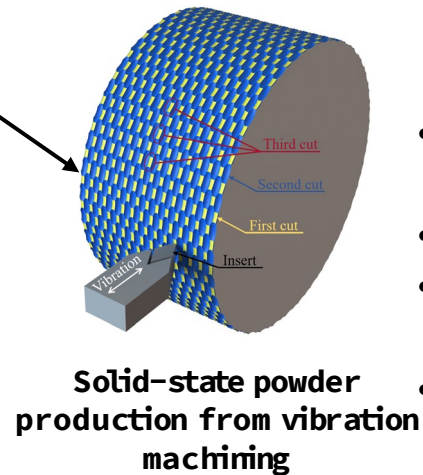
Powder Production Routes



- Energy intensive
- Low size yield
- Internal porosity
- Impurity induced from recycled contamination



Raw metal billets

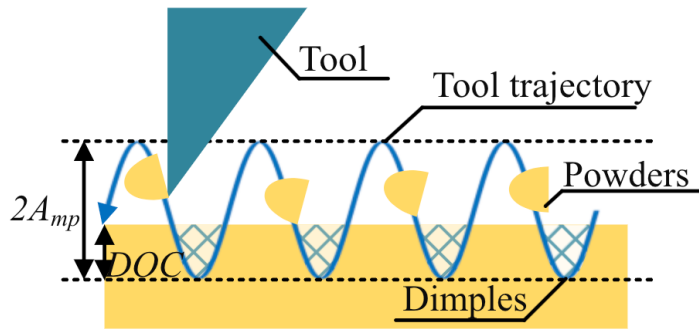


- Solid-state and low energy consumption
- High size yield
- Compatible with a wide selection of (recycled) materials
- (Potentially) high quality and high efficiency

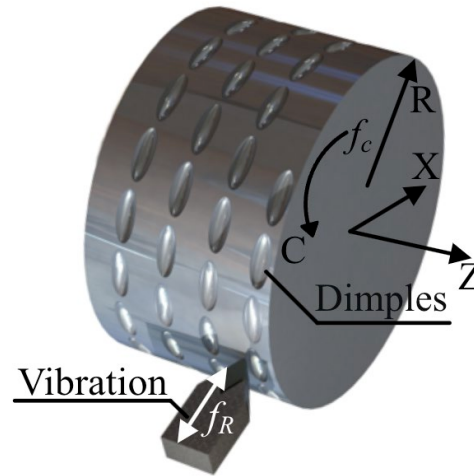


Metal powders

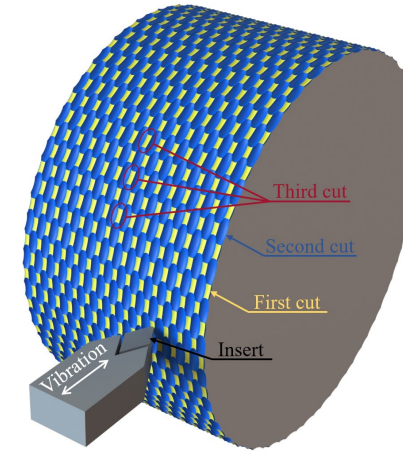
Concept of Powder Generation by Vibration Machining



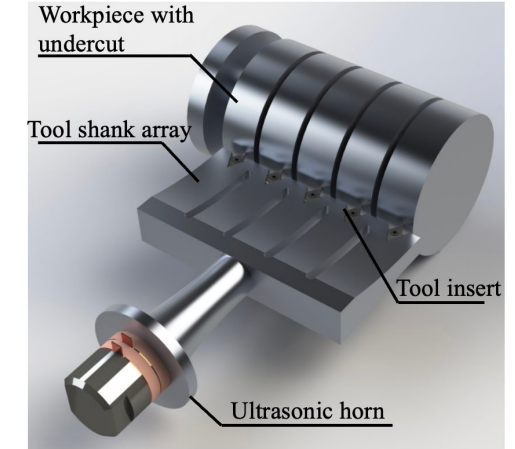
Discrete chips (powders) collected during vibration machining:
~30k powders per second



Implementation in a turning operation for continuous production

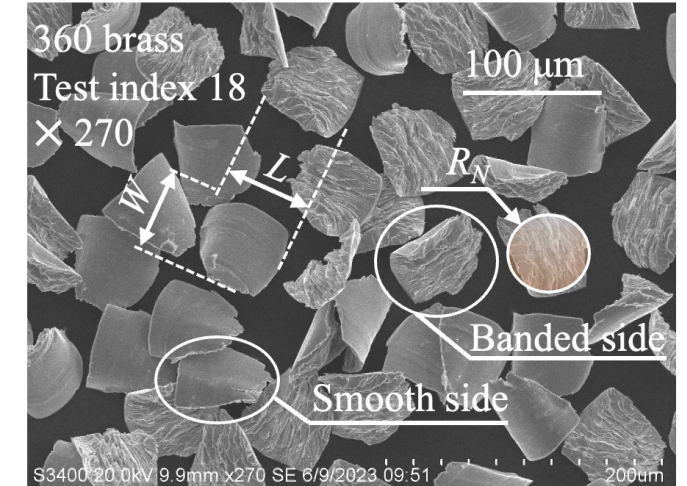
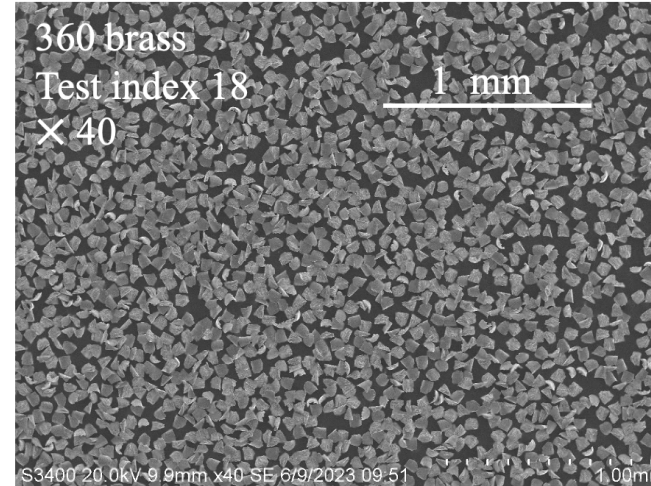
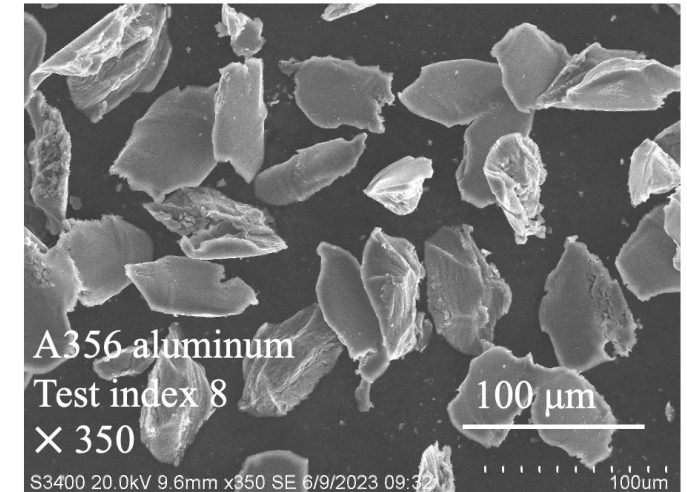
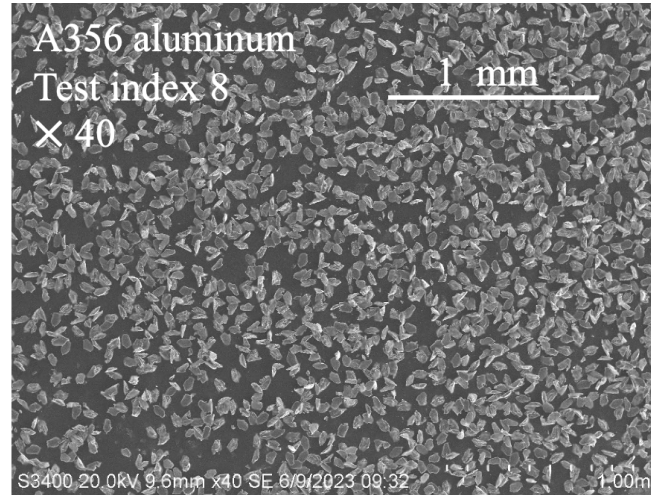
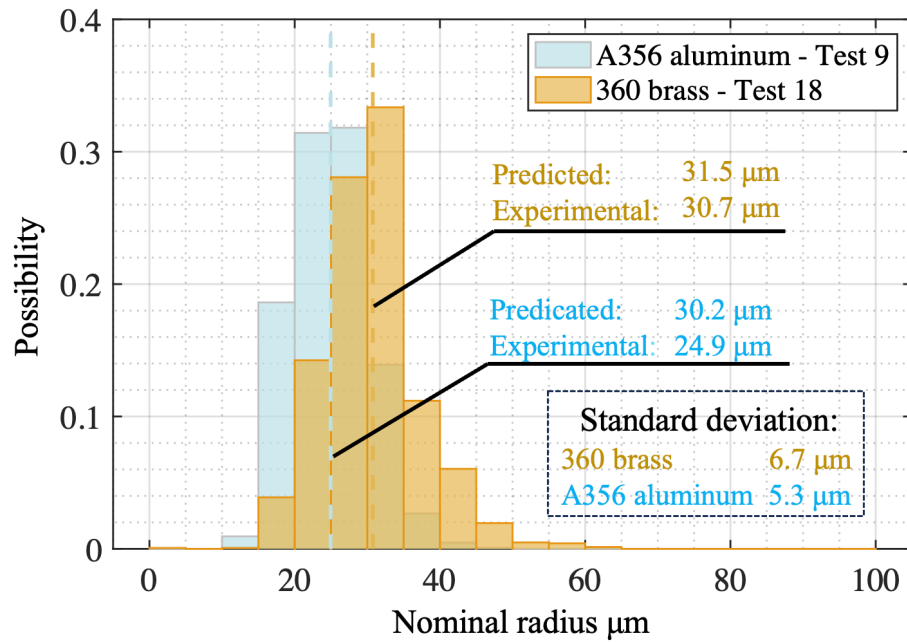


Tool path design to achieve consistent powder morphology over repeated cuts



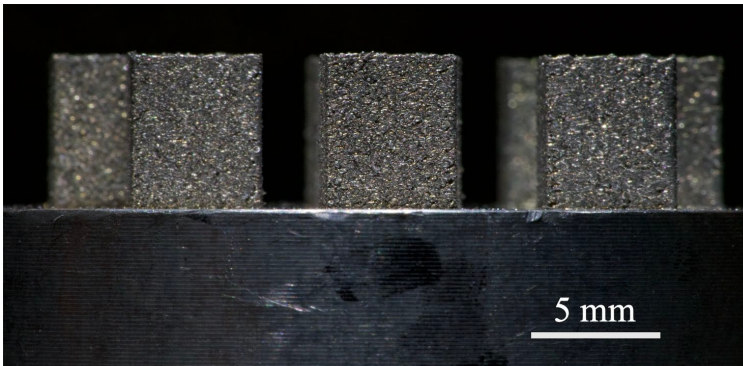
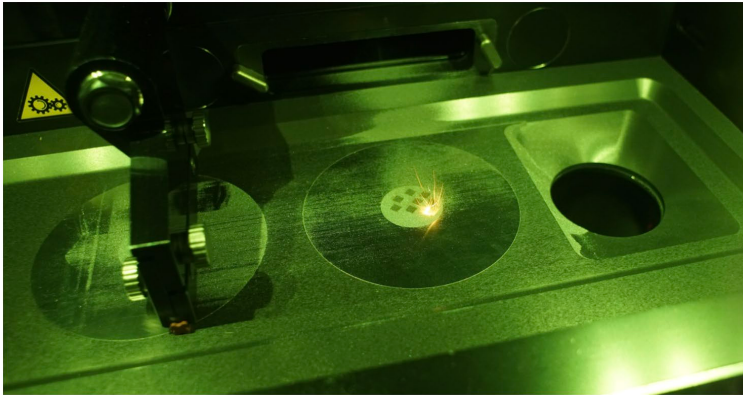
Concept for parallelizing the process for high efficiency

Preliminary Results

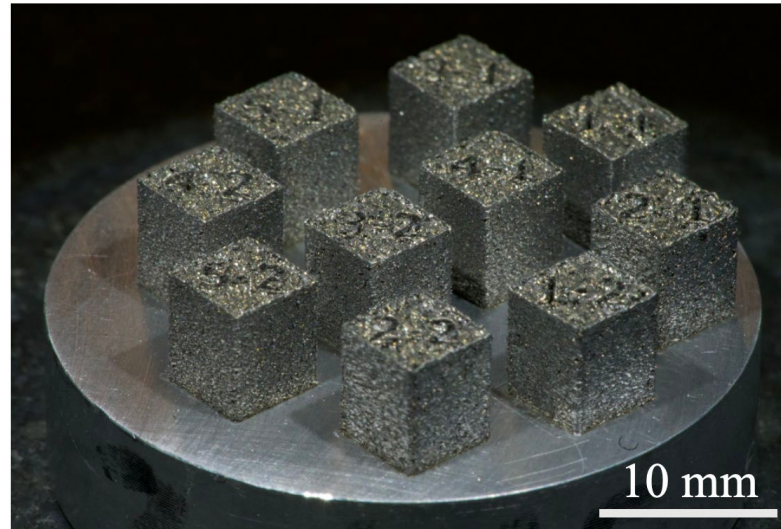


Printing Results

- 34 grams of A356 Aluminum powders
- Powder 60 x 60 x 20 μm
- Laser powder bed fusion



Hatch spacing 100 μm	Layer thickness 20 μm	Laser spot size 55 μm	Substrate preheating No
Sample index		Laser power	Scan speed
1-1, 1-2		200 W	1400 mm/s
2-1, 2-2		175 W	1200 mm/s
3-1, 3-2		175 W	1400 mm/s
4-1, 4-2		175 W	1600 mm/s
5-1, 5-2		150 W	1400 mm/s



Research Directions

- Further process capabilities:
 - Powder morphology (quasi-spherical)
 - Material compatibility (ductility)
- Characterize powders:
 - Flowability
 - Porosity/Grain refinement
- Printability
 - Porosity
 - Grain structure
 - Part quality
 - Feasibility for DED

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Powder Collection

- 90% efficiency

