



Powder Basics

Brought to you by:

Metal Powder Works, GranuTools & TBGA
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The objective of this workshop is to introduce several powder concepts and principles as well as measurement methods to describe how powders behave.

Reference: Metal AM: “Understanding Metal Powder Requirements for Additive Manufacturing: Views From the Industry”

Barnes, DeHoff & Francqui

<https://www.metal-am.com/wp-content/uploads/sites/4/2019/10/Metal-AM-Autumn-2019-sp-1.pdf>

- Individual powder characteristics influence the powder population
 - Size
 - Shape
 - Satellites
 - Electrostatic characteristics
 - Materials Science (diffusion, oxidation, hydroaffinity)
- Powder Populations, i.e. “Powder” can be made of sub populations which dictate bulk performance
 - The overall Powder Size Distribution matters, as can the d10, d50 and d90 – What’s that?
 - Presence of fines or particles < 20um
 - Bulk density – can I get to 45% dense?
 - Denudation moves that highly flowing powder
- What influences how powder moves and packs and how do we measure it?
 - Small and irregular require more energy than large and round
 - Hall Flow – circular orifice with 30 degree walls – okay when you want to move through a circle w/30 deg walls
 - Recoater blades have more to do with angle of repose and avalanche
 - Packing influenced by natural packing initially, we don’t really get “tapped” density in AM

A Closer Look at Powder

- Most metal powder is water atomized
- Almost all AM powder is gas/plasma atomized
- Polymer powders are mostly round
- Focusing on metal powders
- Sphericity is a continuum and not a yes or no

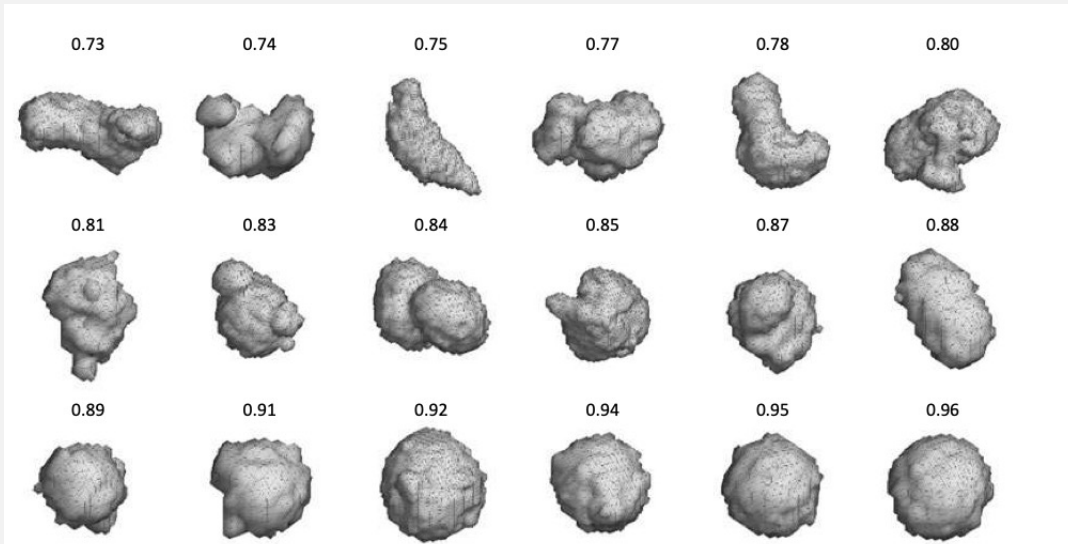
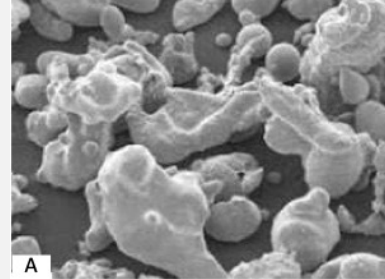
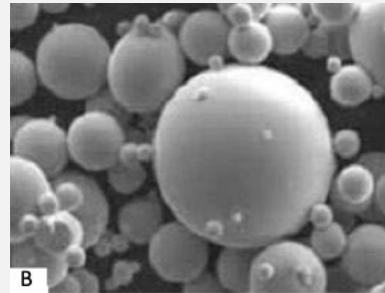


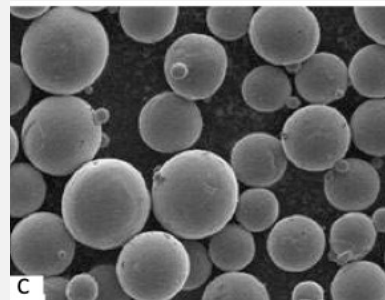
Fig. 5 Measurements of sphericity by CT [4]



Water Atomized
Irregular



Gas Atomized
Spherical



Plasma Atomized
Spherical

Size Matters! And Shape...and Combinations

Powder Size Distribution

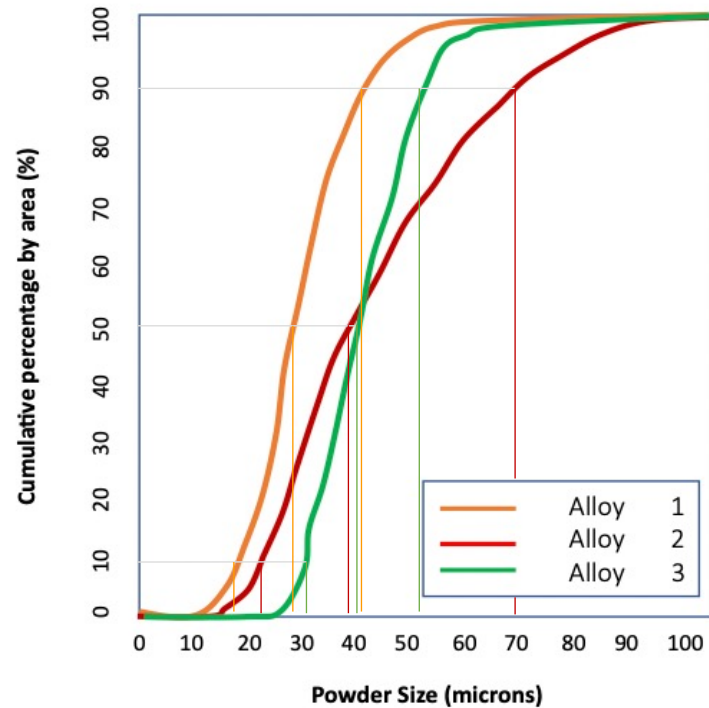
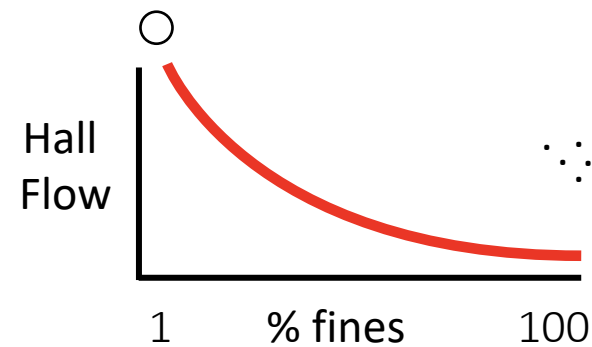
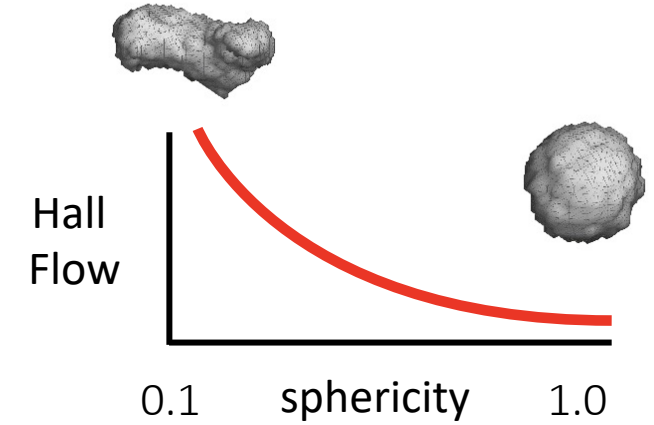
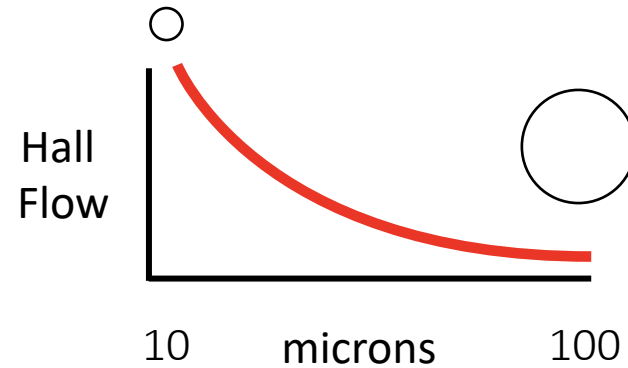
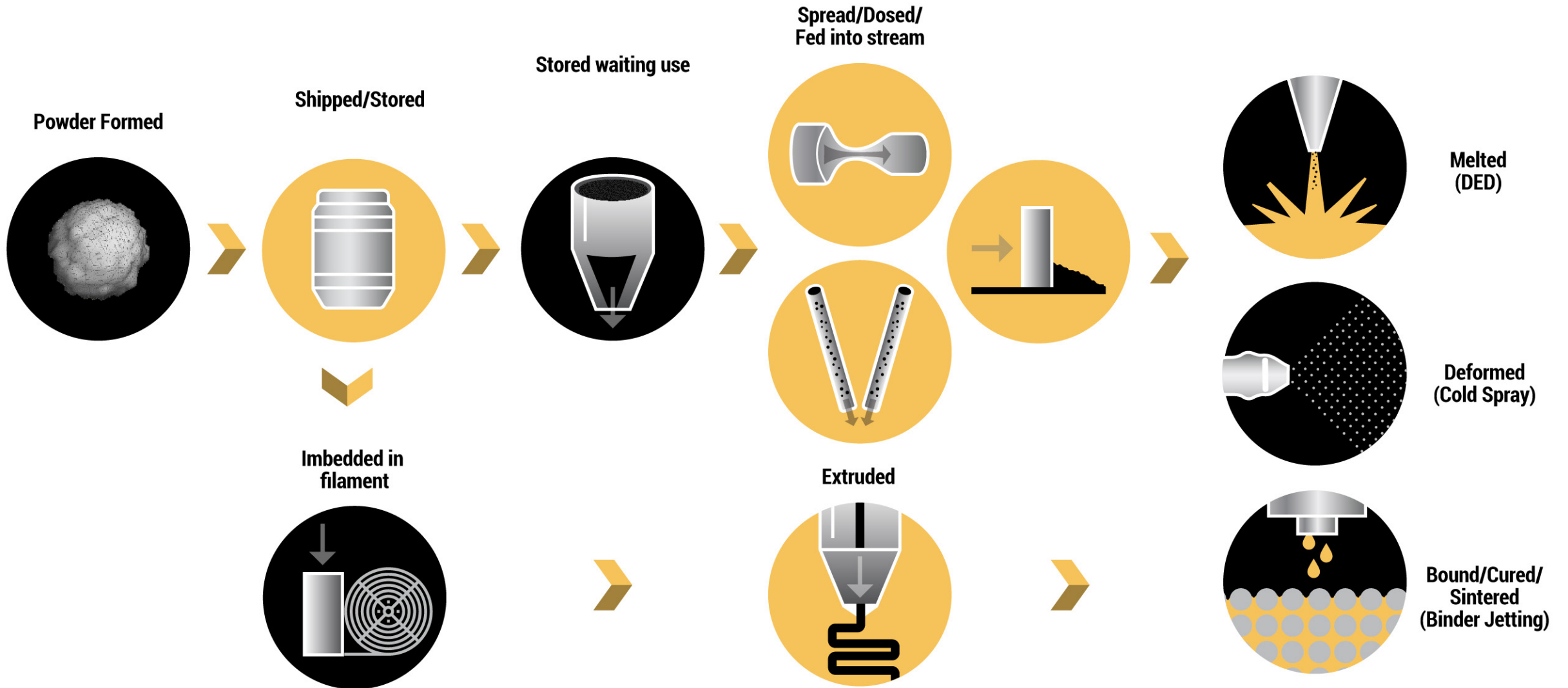


Fig. 3 The effect of alloy on powder production efficiency or PSD [2]

Alloy	D10	D50	D90
1	17	28	41
2	22	39	70
3	31	40.5	53



AM from the Powder Point of View



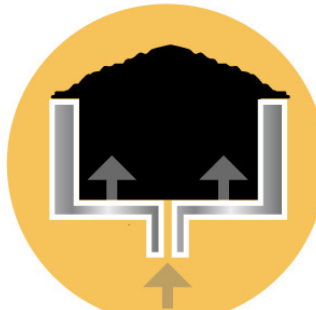
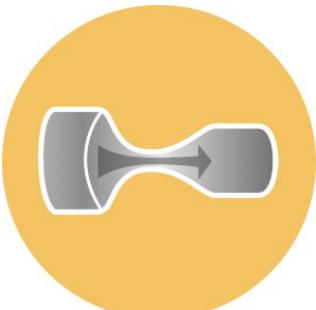
Processing Dictates Powder Requirement

Powder shipped in appropriate container

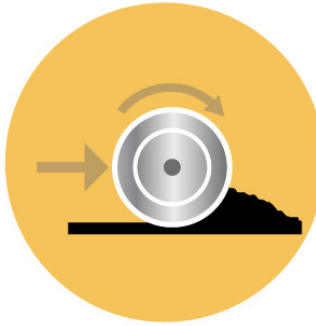
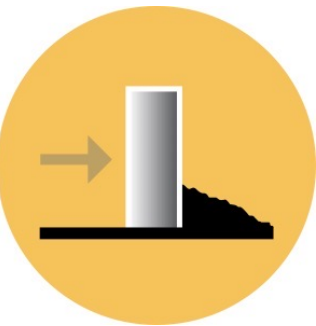


Gravity fed hopper, either circular or rectangular orifice



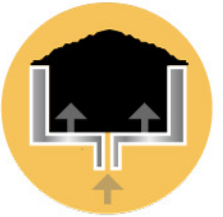



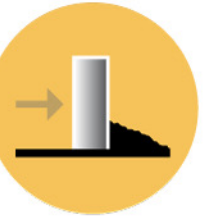
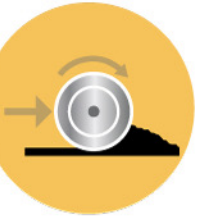
Application in a reservoir, or injected into a gas flow



Distribution via dosing, blade or roller movement

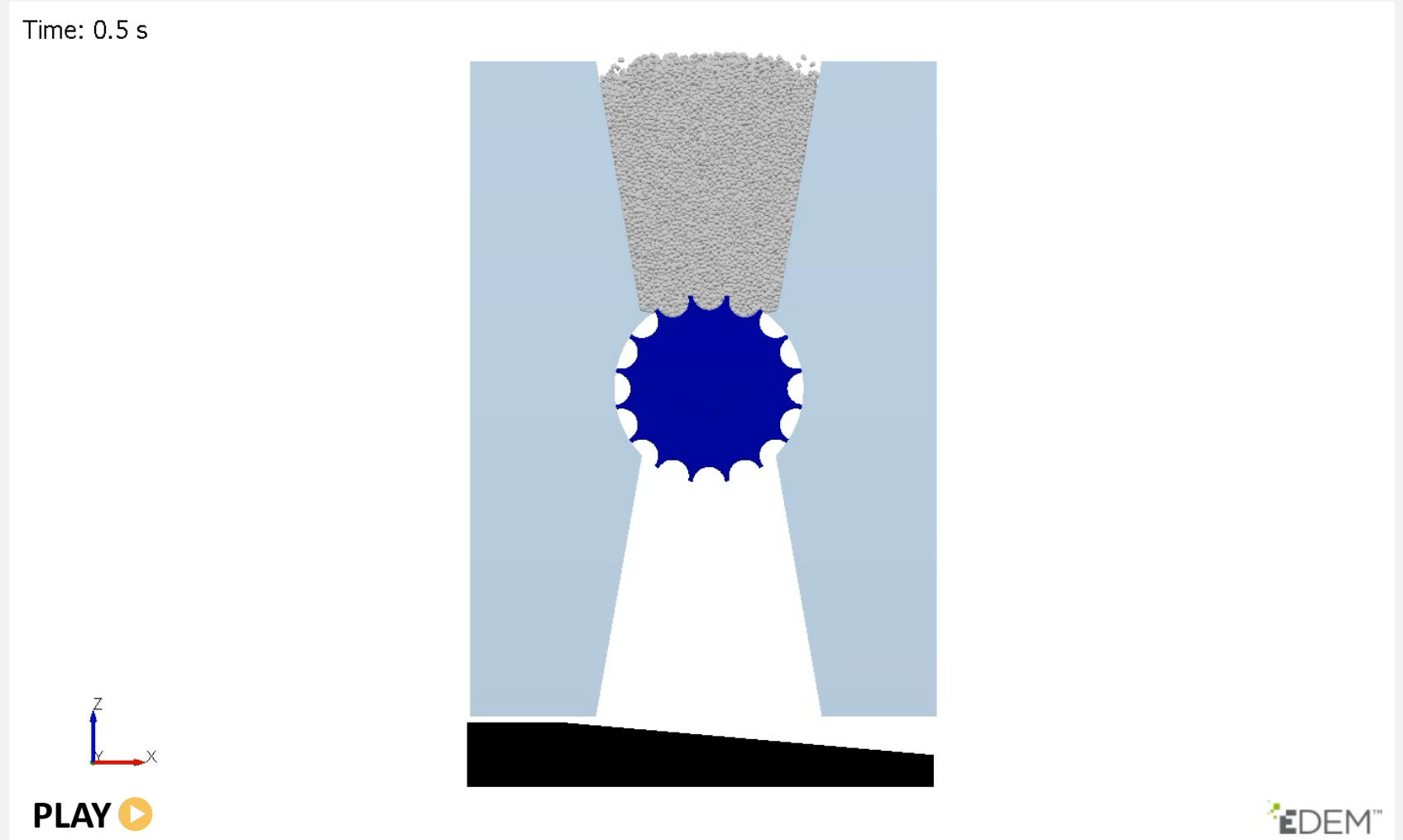


What Measurement Applies?

								
Hall Flow	✓							
Tapped	✓	✓	✓					
Angle of Repose						✓	✓	✓
Charge	✓	✓	✓			✓	✓	✓
Cohesion	✓	✓	✓			✓	✓	✓

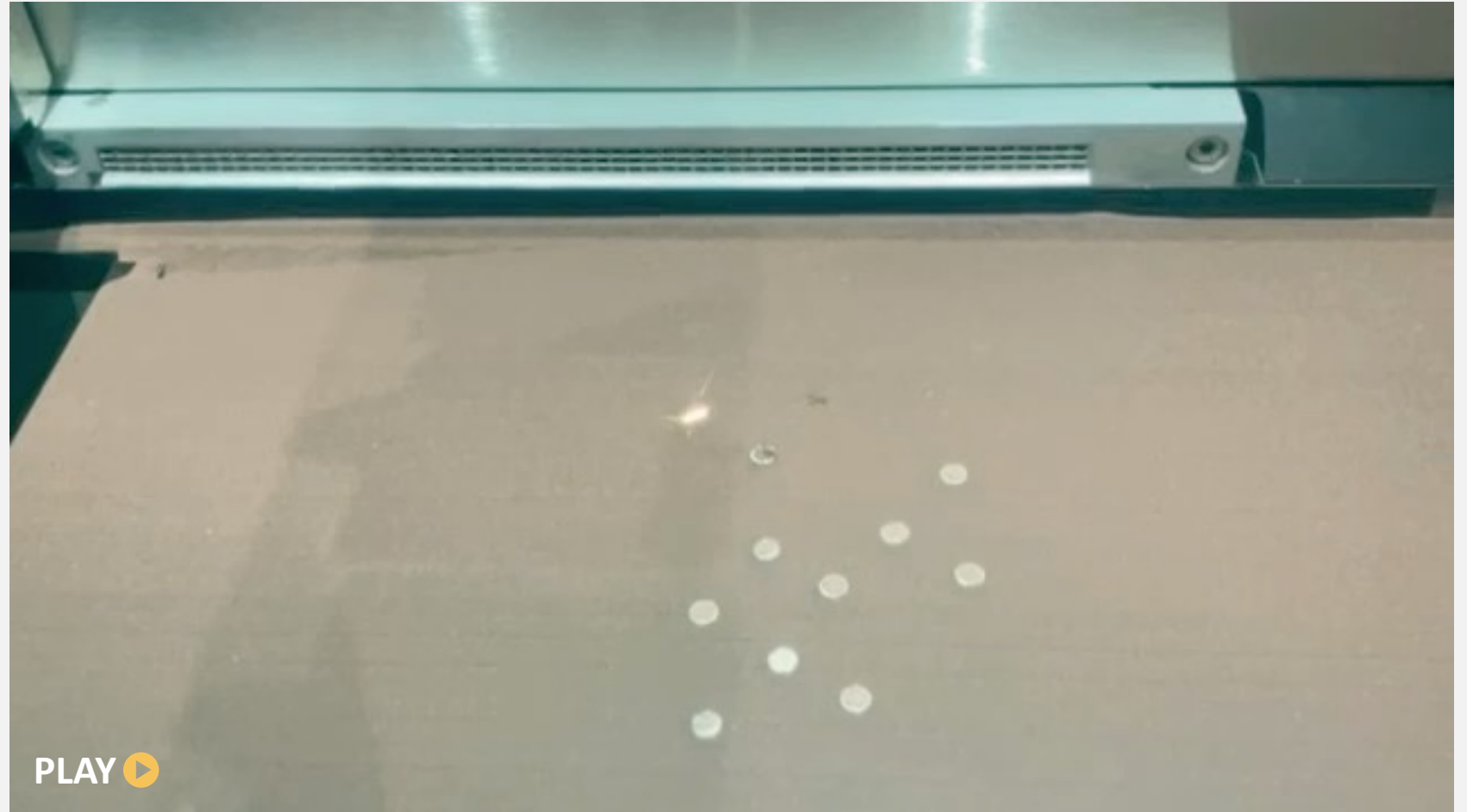
Dosing Wheel

EDEM and The Barnes Global Advisors collaborated to simulate the dosing wheel effect using powder characteristics. This visualization shows the principle of how a dosing wheel distributes powder.



Recoater Blade

Properly dosed.

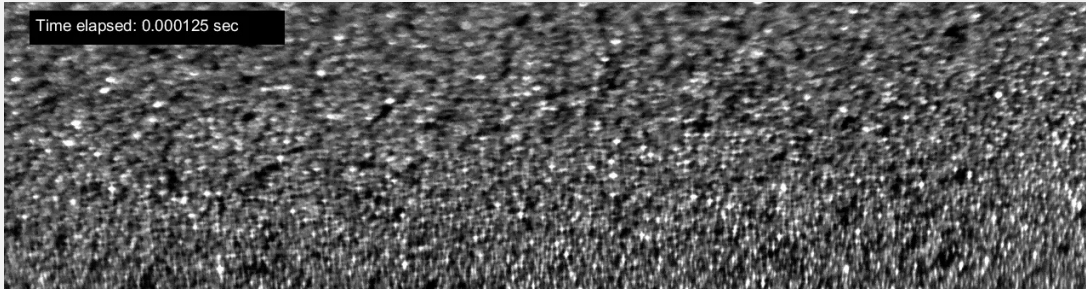


Recoater Blade

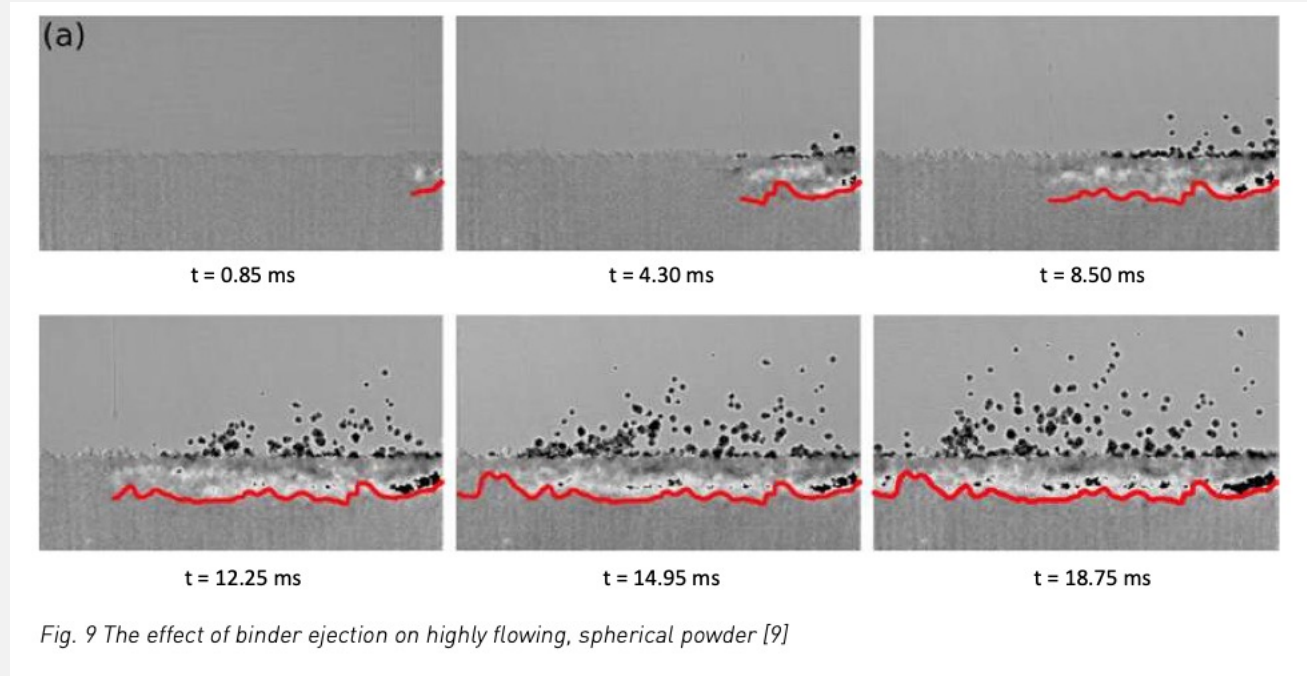
Too much powder is applied
and **not** properly dosed.

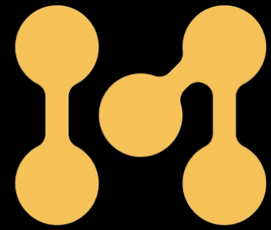


Influences of the Laser/Binder



P. Bidare, I. Bitharas, R. M. Ward, M. M. Attallah, A. J. Moore, Acta Materialia 142 (2018) 107-120





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— W O R K S —

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