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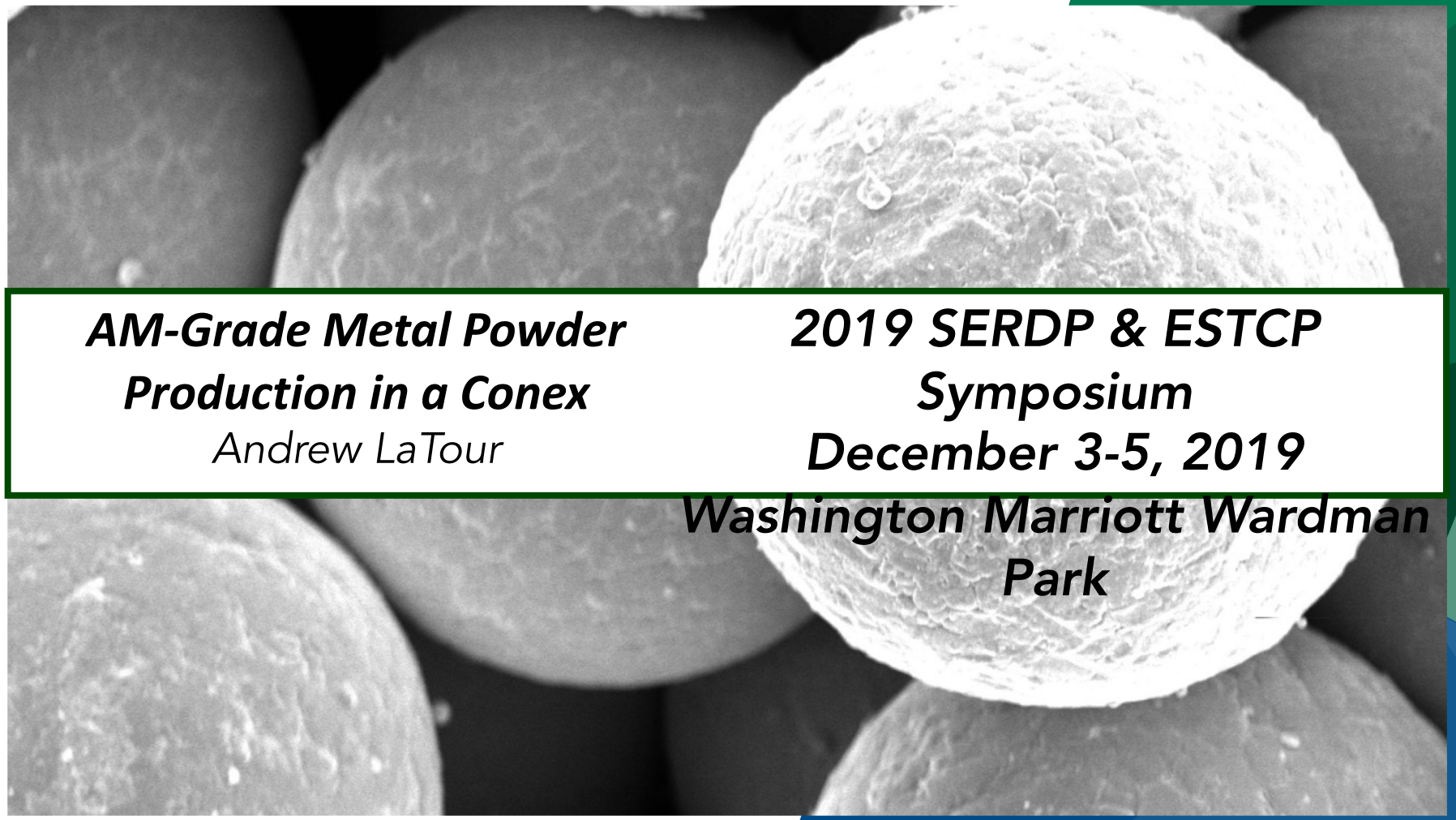

AM-Grade Metal Powder Production in a Conex

Andrew LaTour

2019 SERDP & ESTCP Symposium
December 3-5, 2019
Washington Marriott Wardman Park

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25 YEARS OF ESTCP
2019 | Enhancing DoD's Mission Effectiveness

PROBLEM

Too much scrap!

Scrap value is only 10% of metal product value

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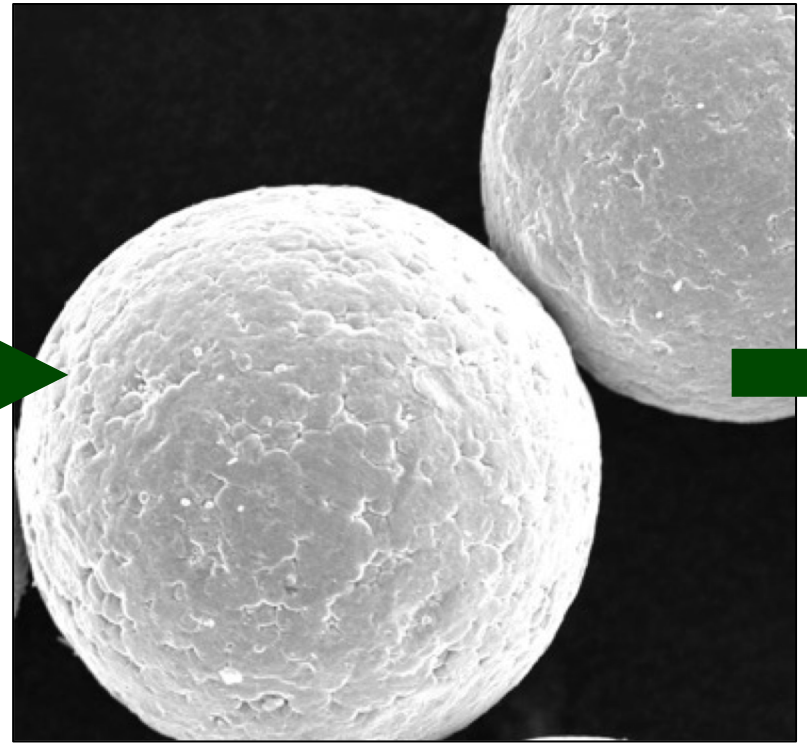
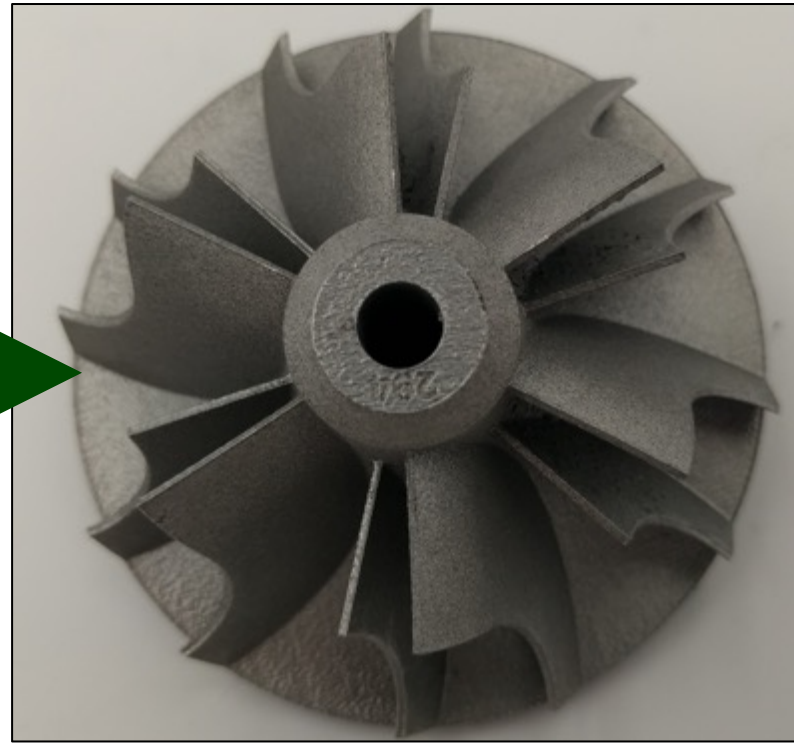
SOLUTION

Recycle Metal Scrap into Additive Manufacturing Grade Powder "ink for metal 3D Printing"





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Our First Mobile Foundry Before and After Deployment

(We added some paint…)

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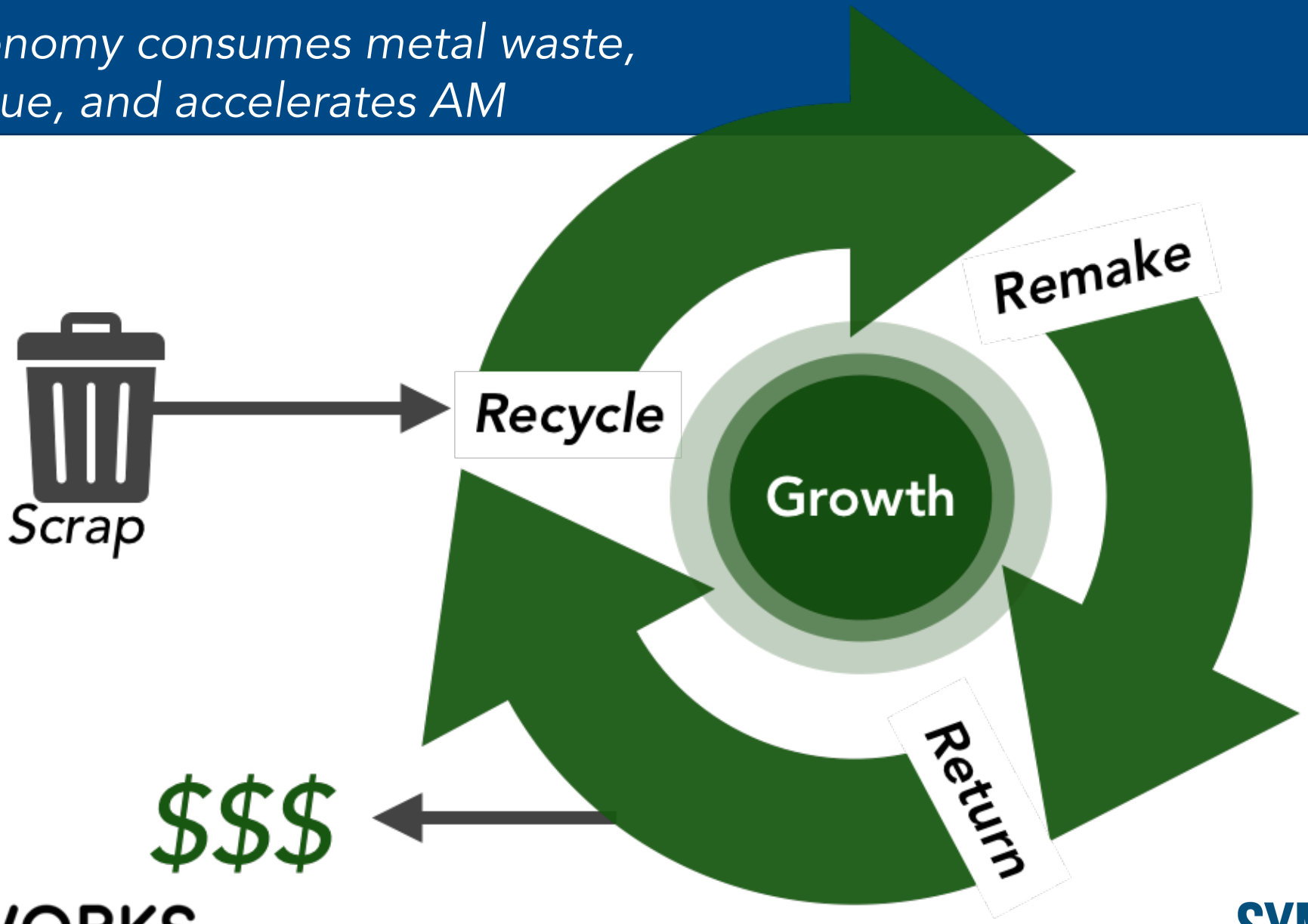
VISION

A circular economy consumes metal waste, generates value, and accelerates AM



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VISION

A circular economy consumes metal waste, generates value, and accelerates AM

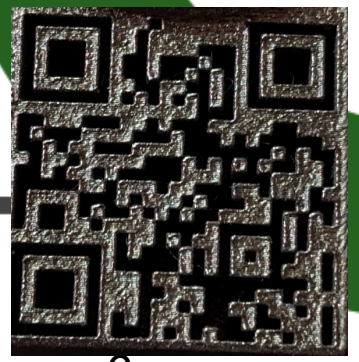
Scrap

Recycle

Remake

Growth

Return



$$$

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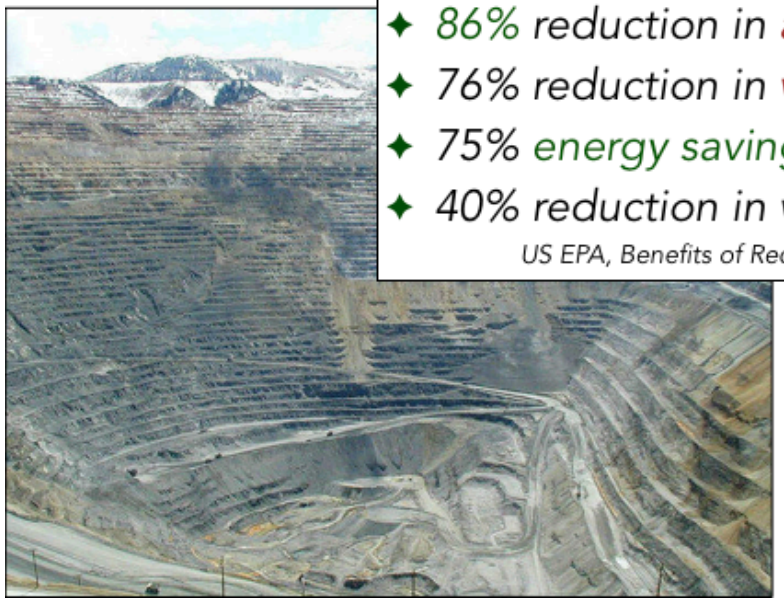
WHY RECYCLE?

Recycling Benefits

- 97% reduction in mining wastes
- 90% raw material savings
- 86% reduction in air pollution
- 76% reduction in water pollution
- 75% energy savings
- 40% reduction in water use

US EPA, Benefits of Recycling Scrap Metal



WHY RECYCLE?

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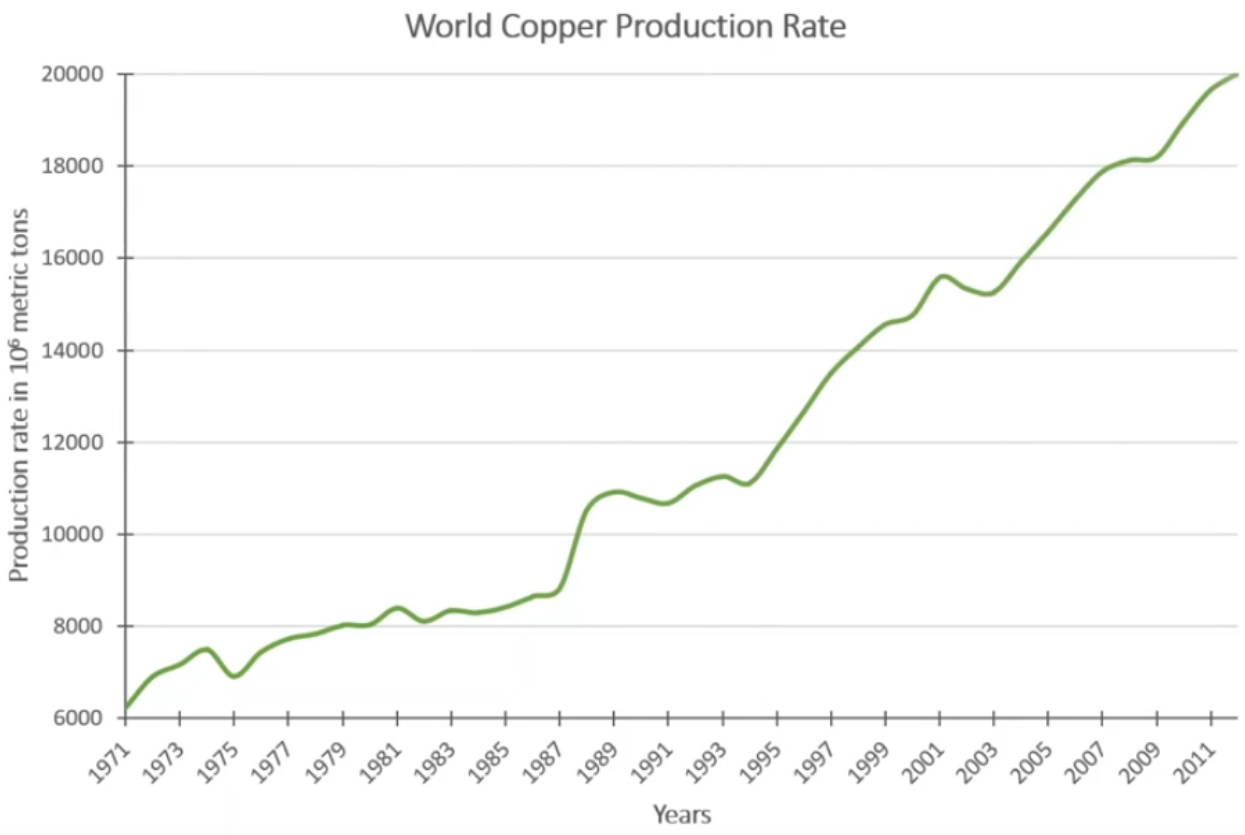
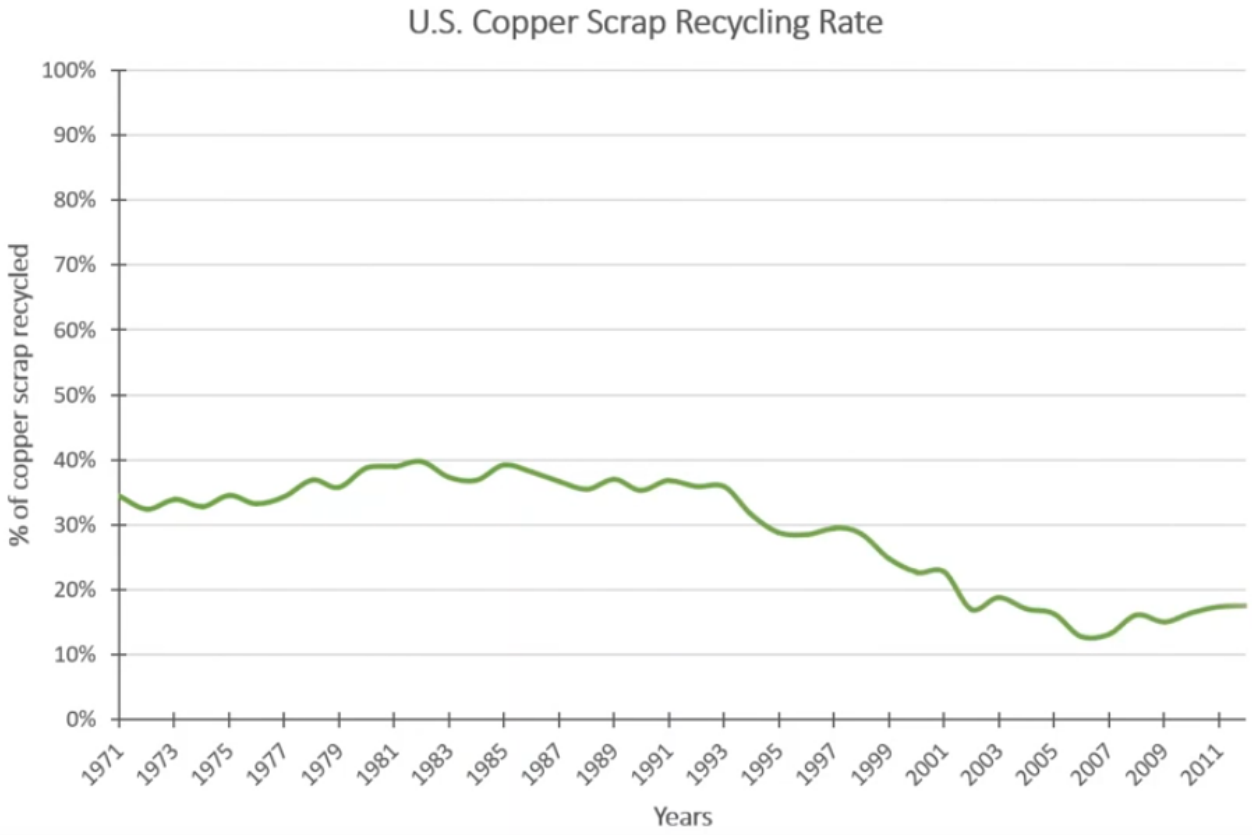
WHY RECYCLE?





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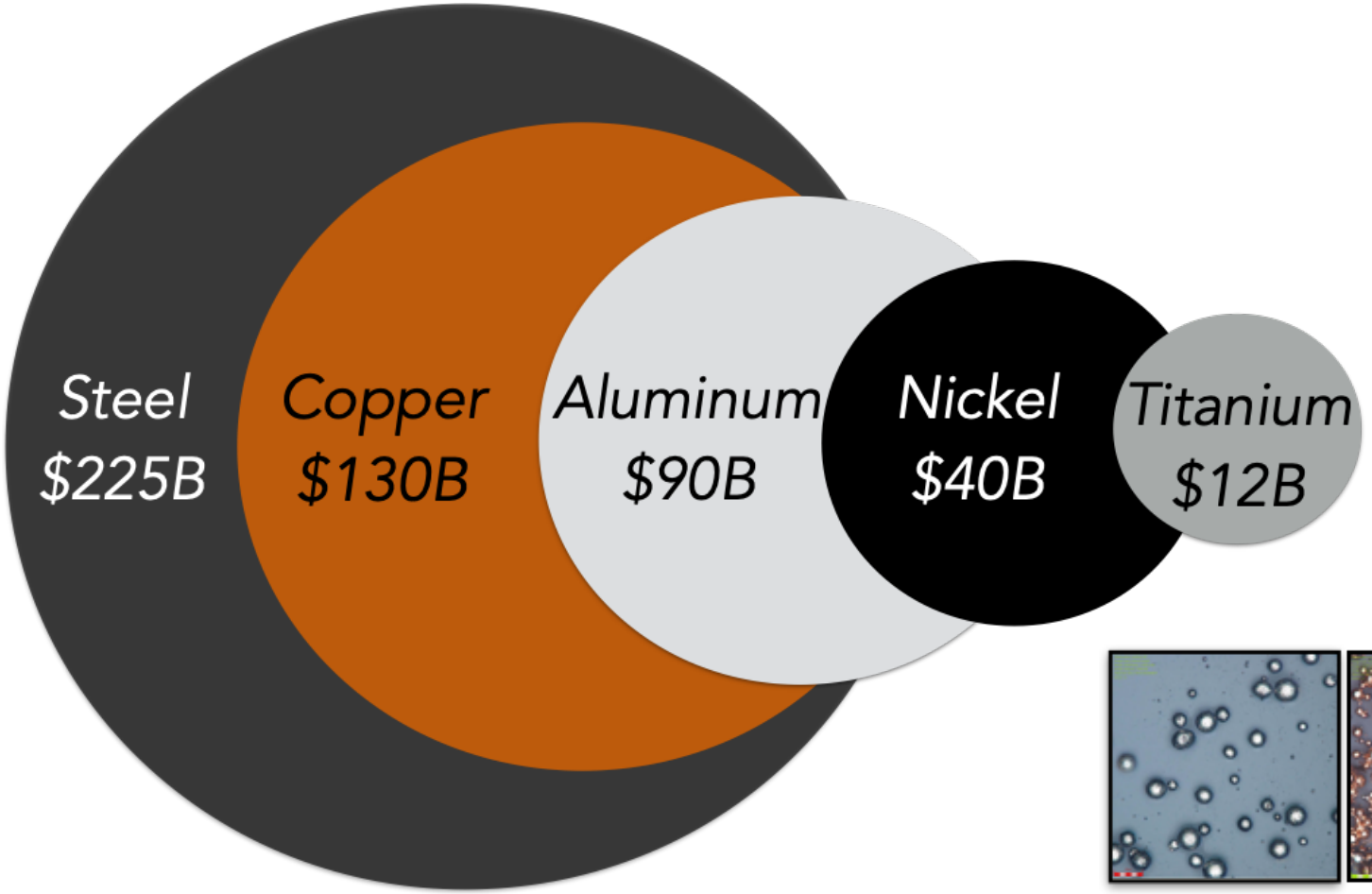
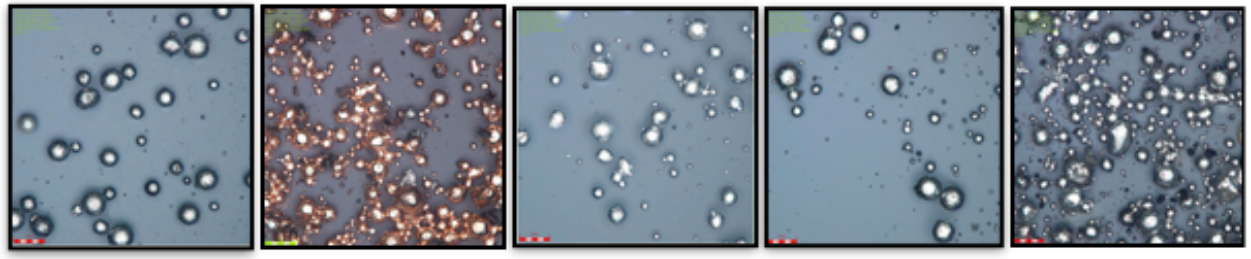
Global Metal Market is valued over $500B

World Bureau of Metal Statistics



MolyWorks has demonstrated each



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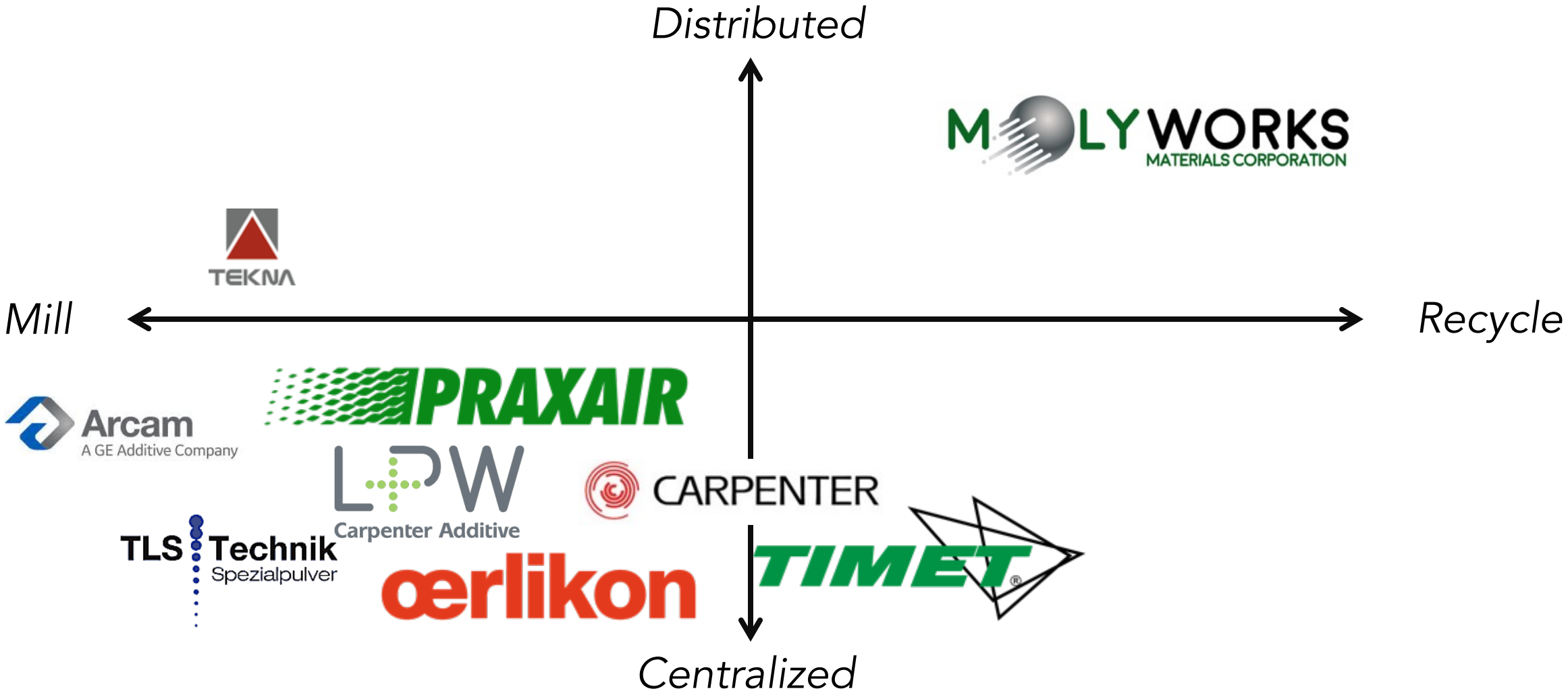
COMPETITION



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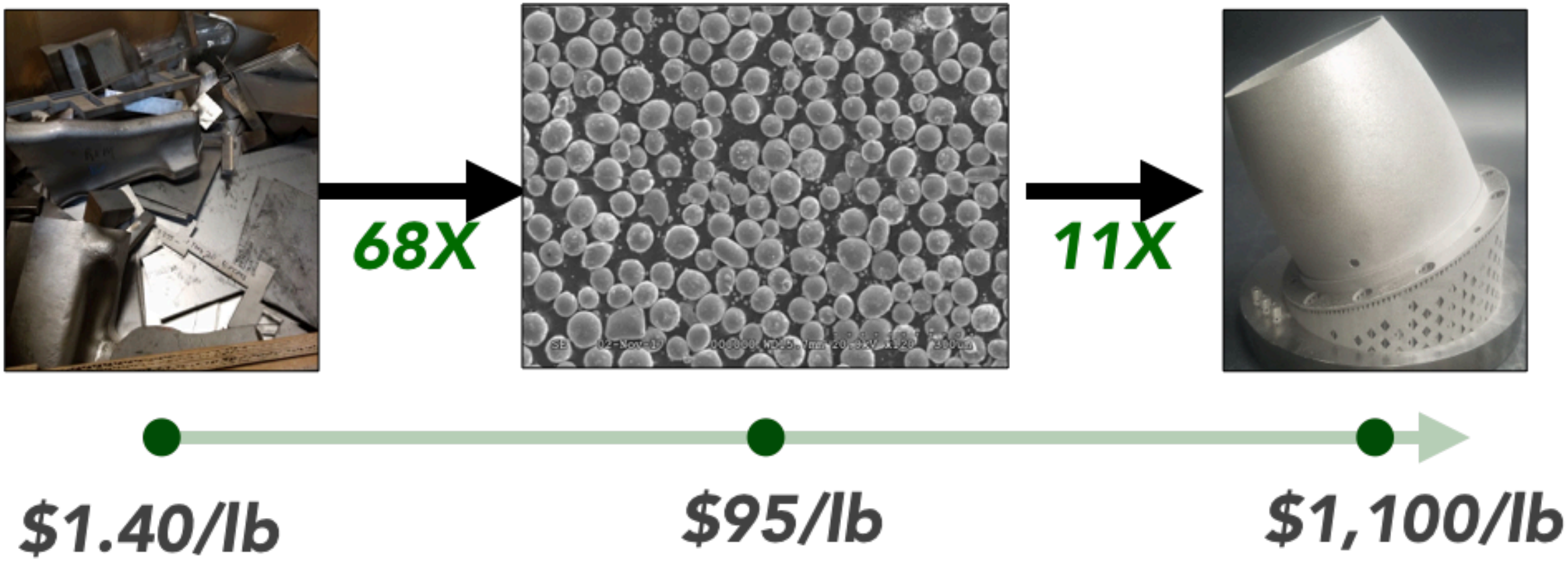
BUSINESS MODEL

MolyWorks converts low value scrap into high value products



*Just a million pounds of scrap can generate **$1B+***

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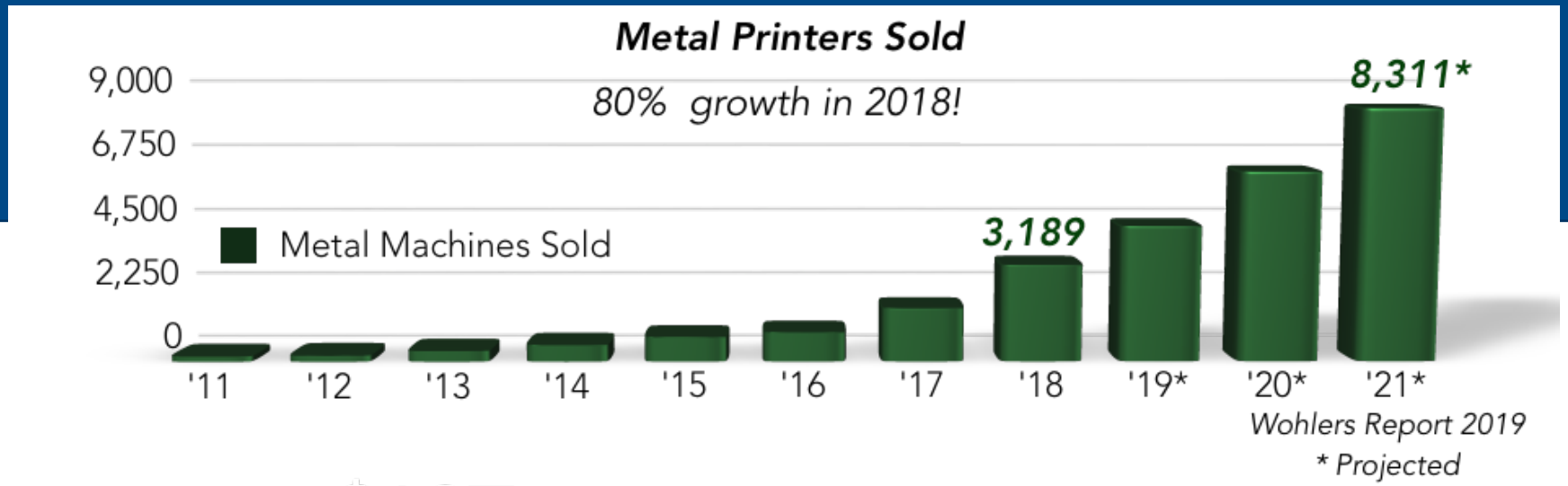
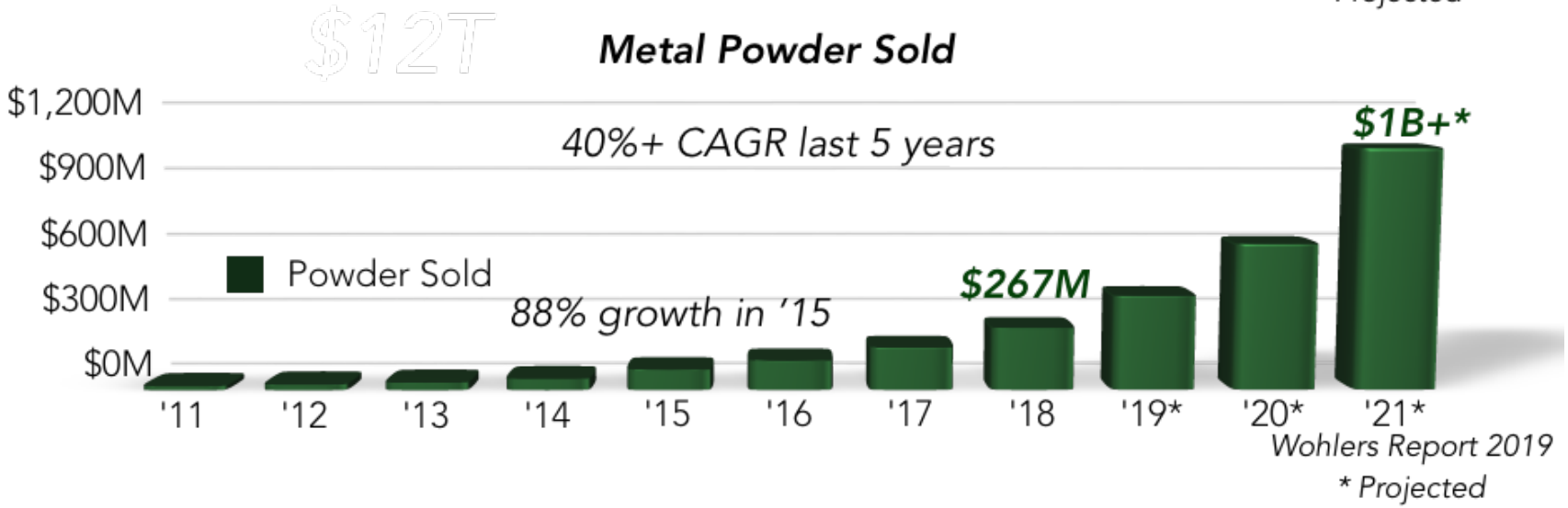
WHY NOW?





Metal Powder sales lag behind printer sales. Printer productivity improved 5x in '18. Qualification assures installed printers will be operated for many years to come.

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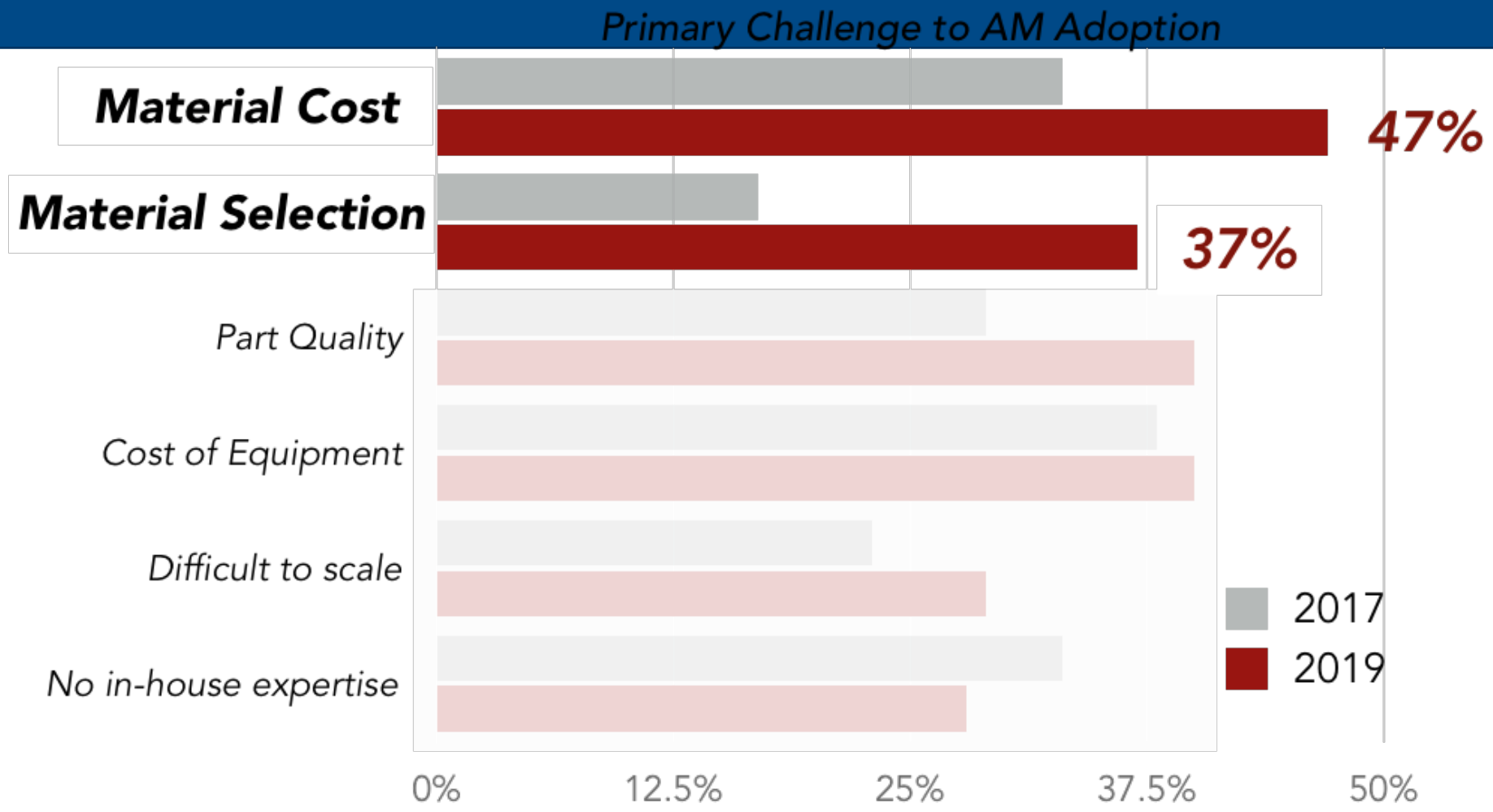
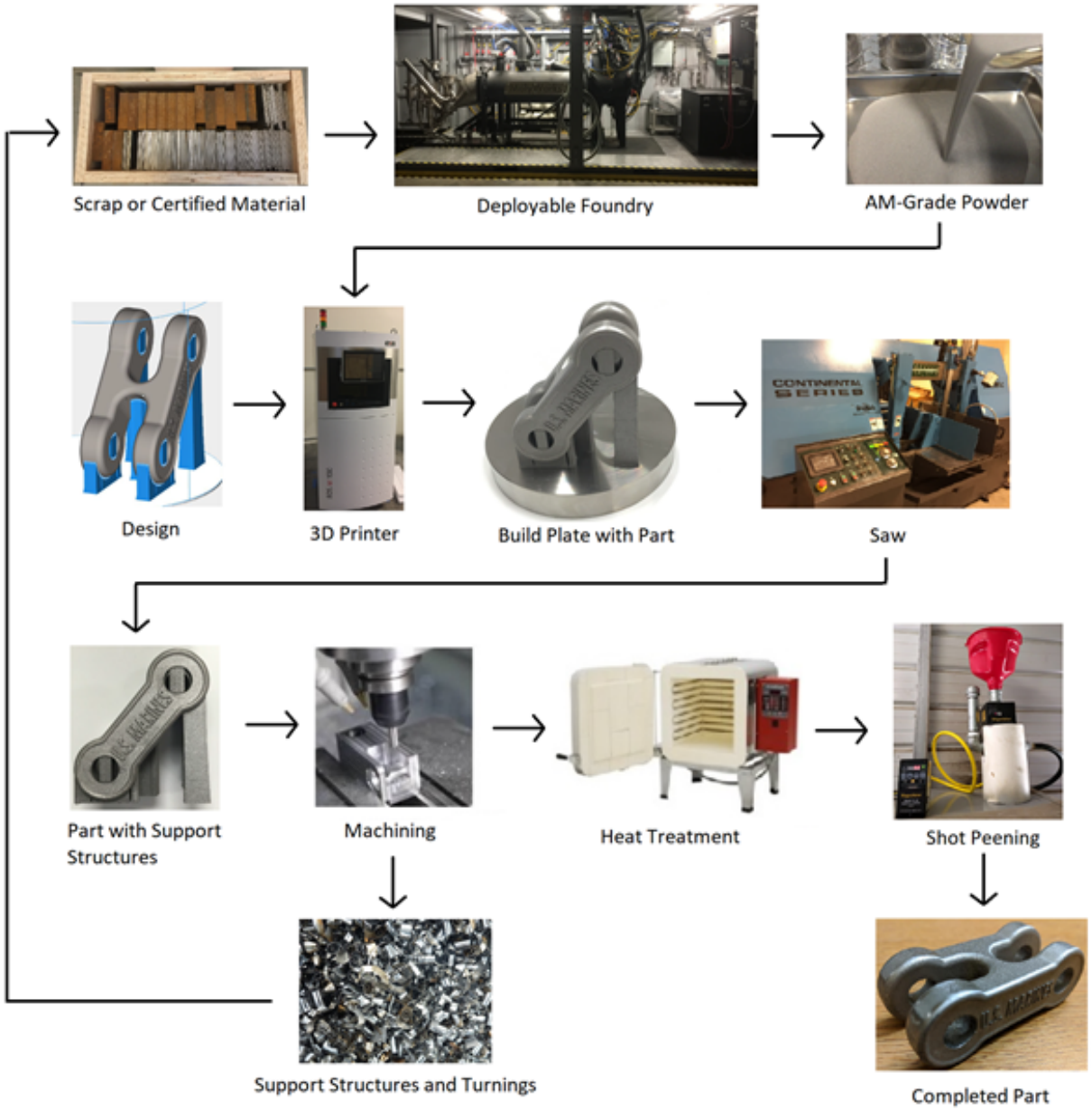
Key Barriers to AM Adoption



PROCESS FLOW



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MELTING

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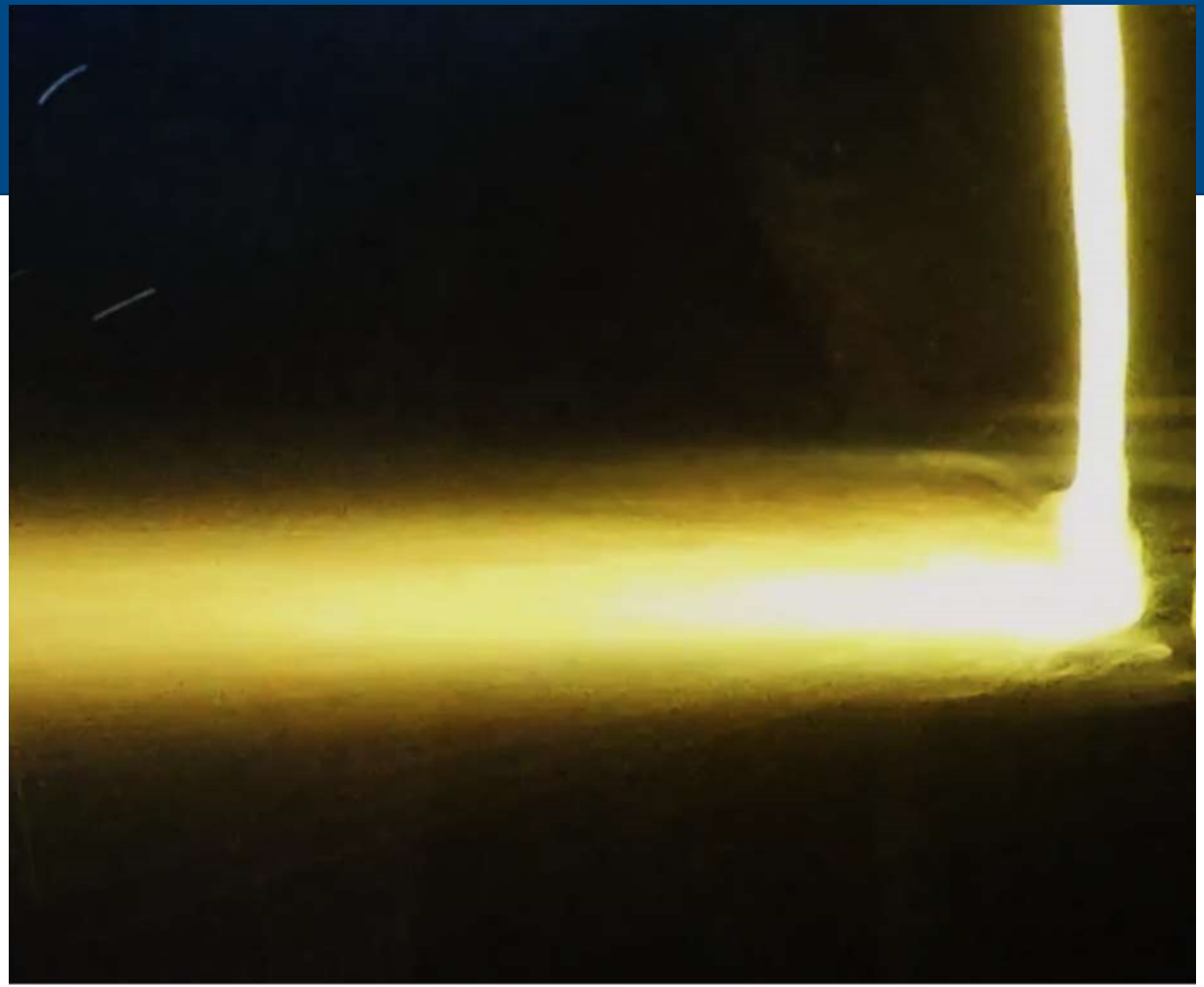
ATOMIZATION



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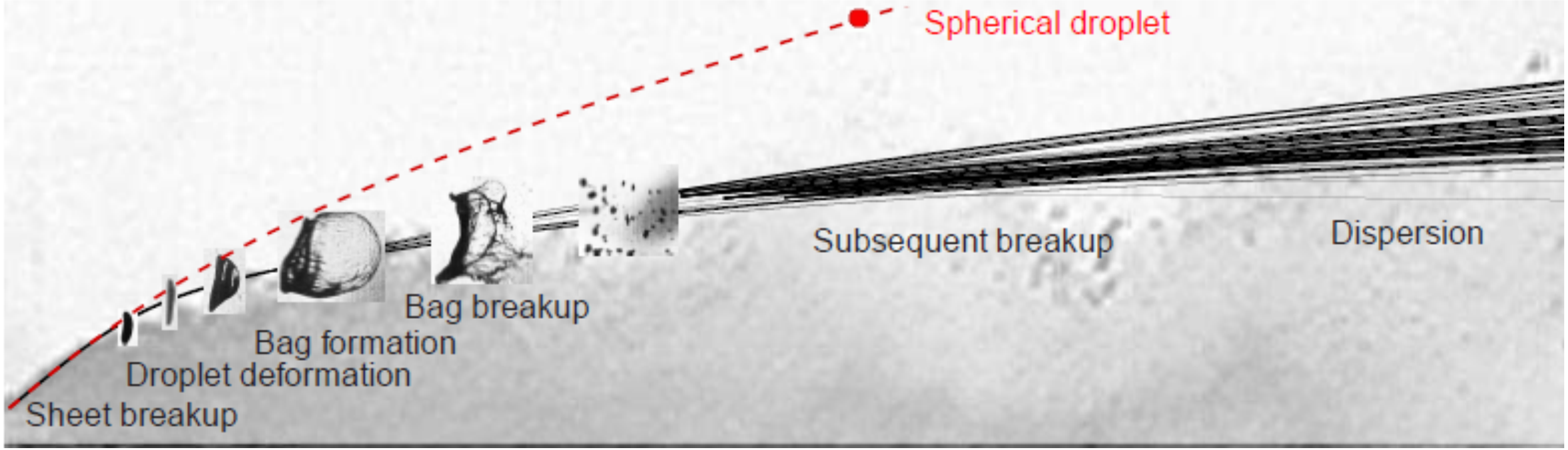
ATOMIZATION MECHANISMS



ATOMIZATION MECHANISMS

Low relative velocities

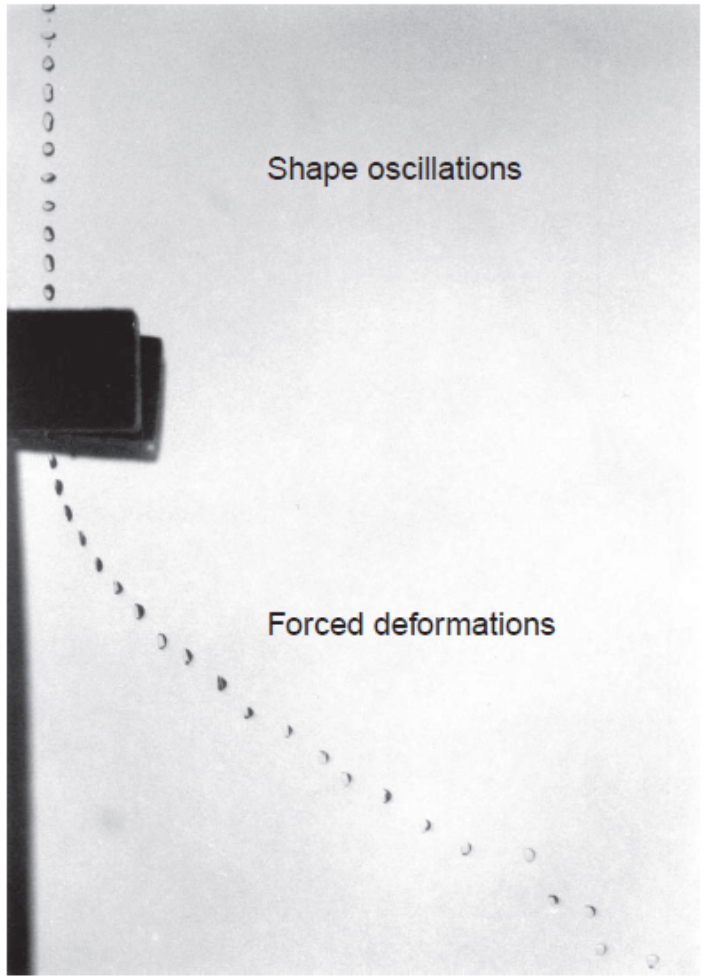


Image source: Wiegand (1987)

Moderate to high relative velocities (top to bottom)

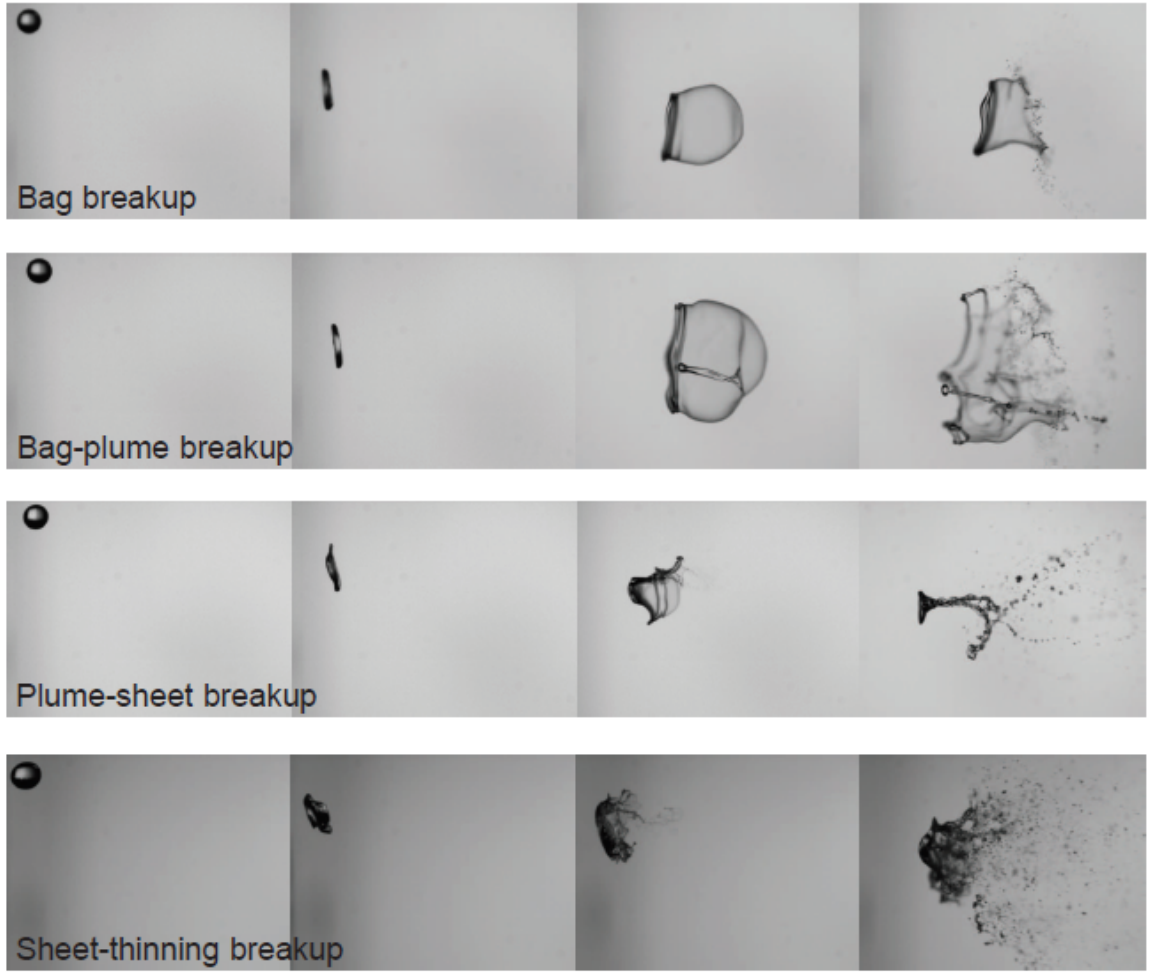


Image source & terminology: Guildenbecher (2009)

ATOMIZATION AT 60KFPS

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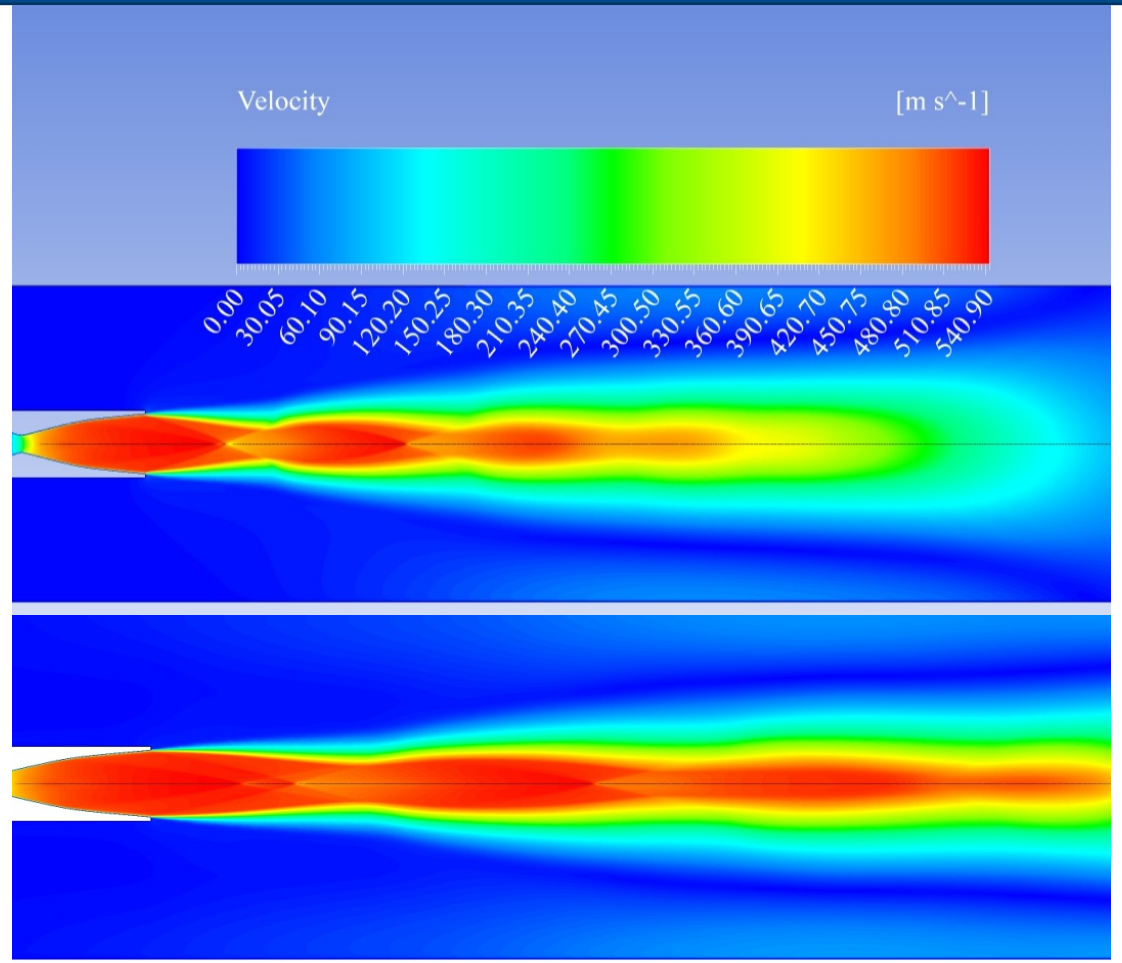
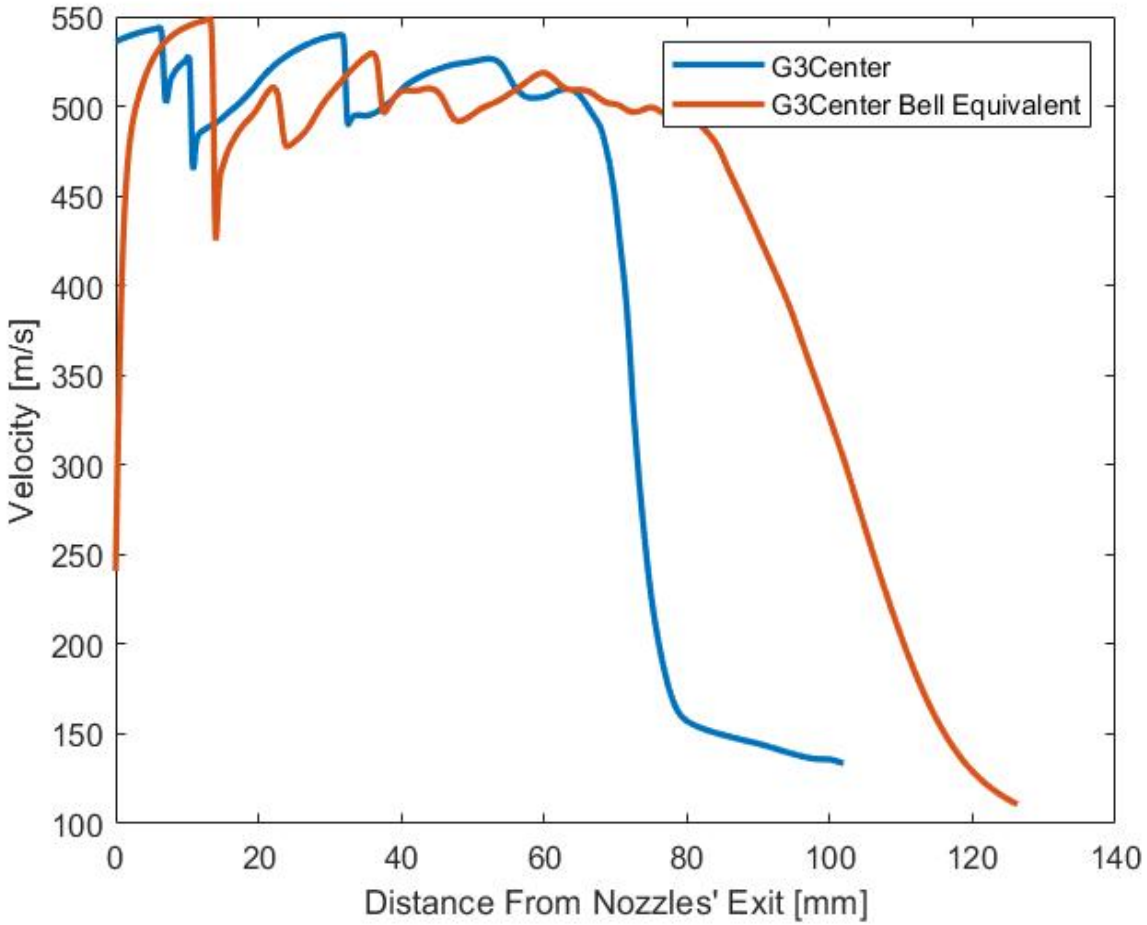
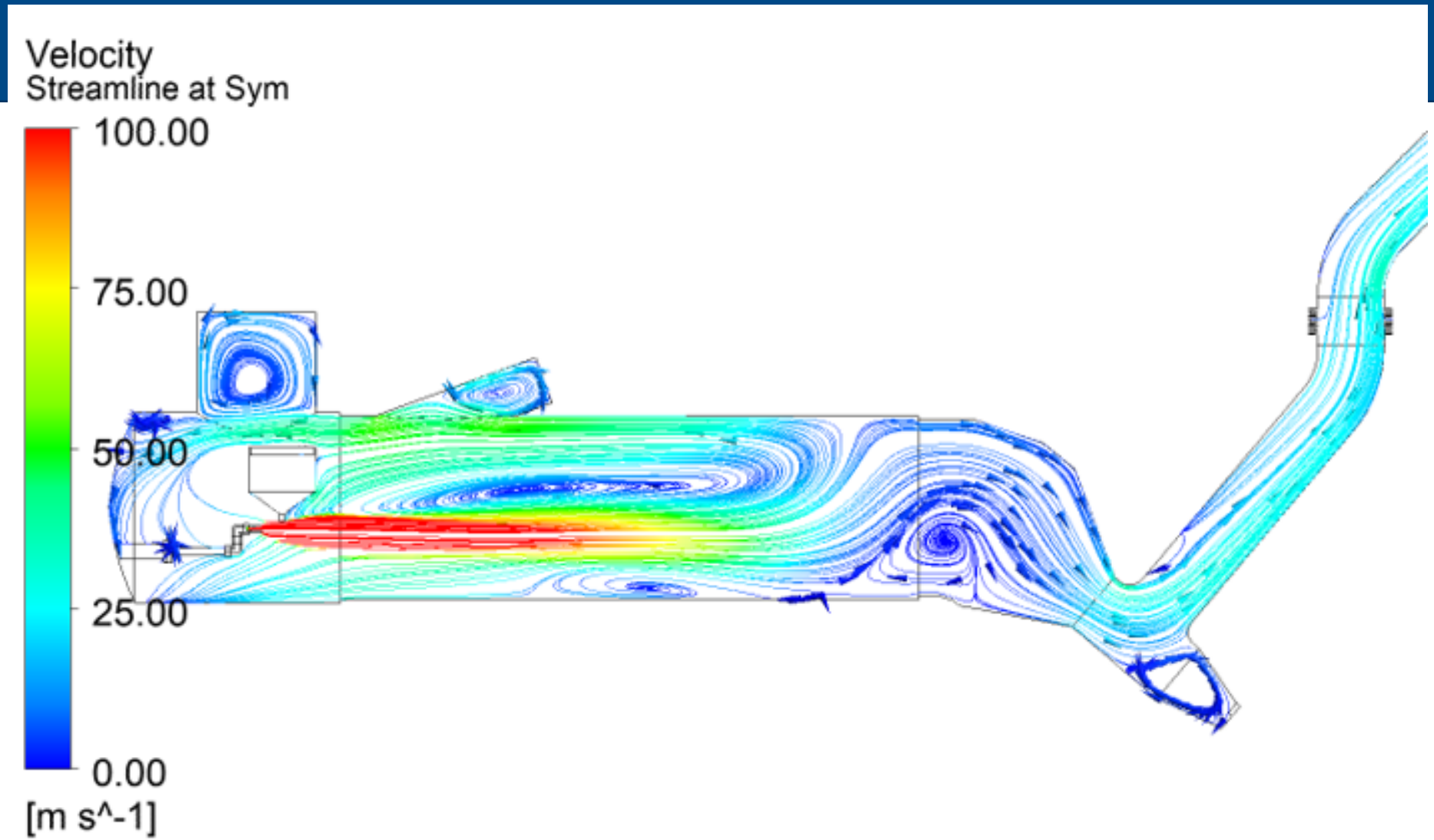
COMPUTATIONAL FLUID DYNAMICS





COMPUTATIONAL FLUID DYNAMICS



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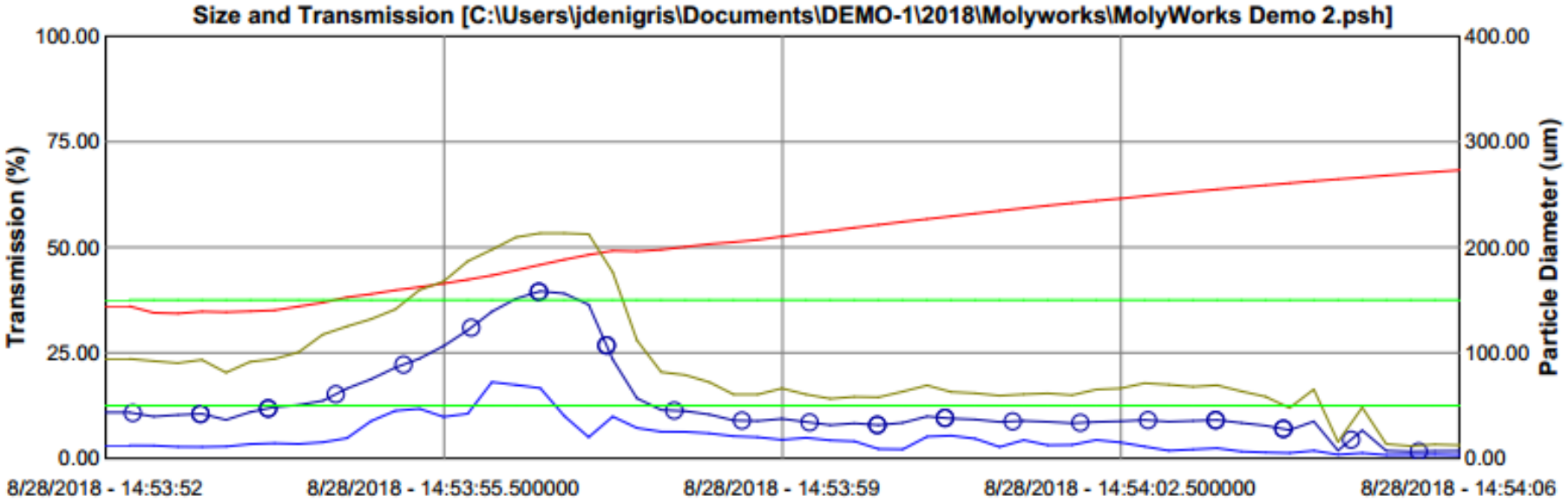
IN-SITU PARTICLE SIZE ANALYSIS

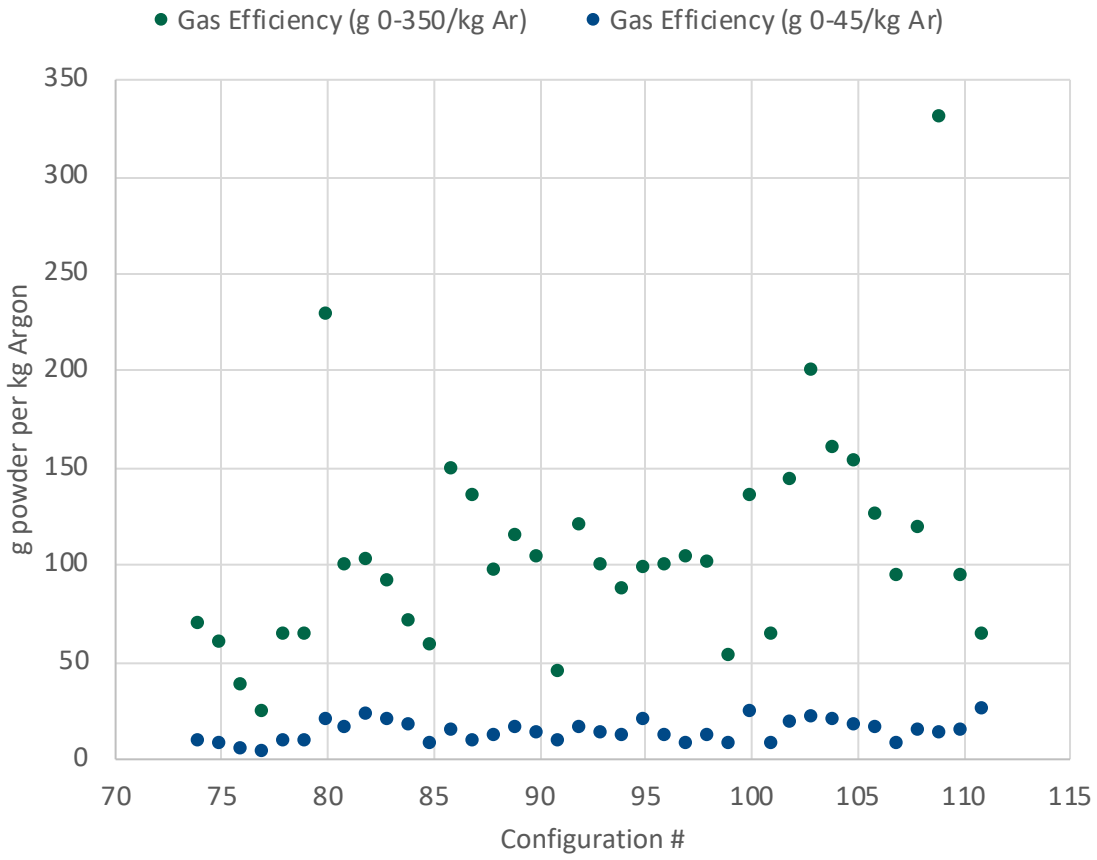
Material : Molyworks Inconel

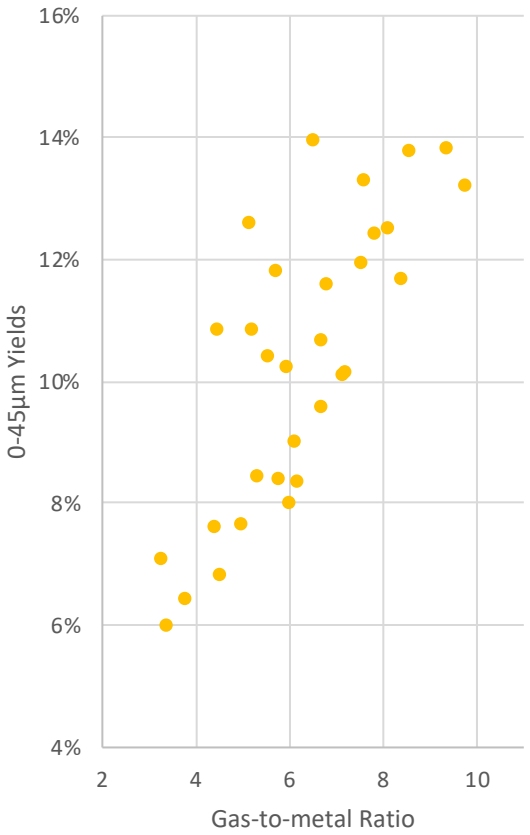


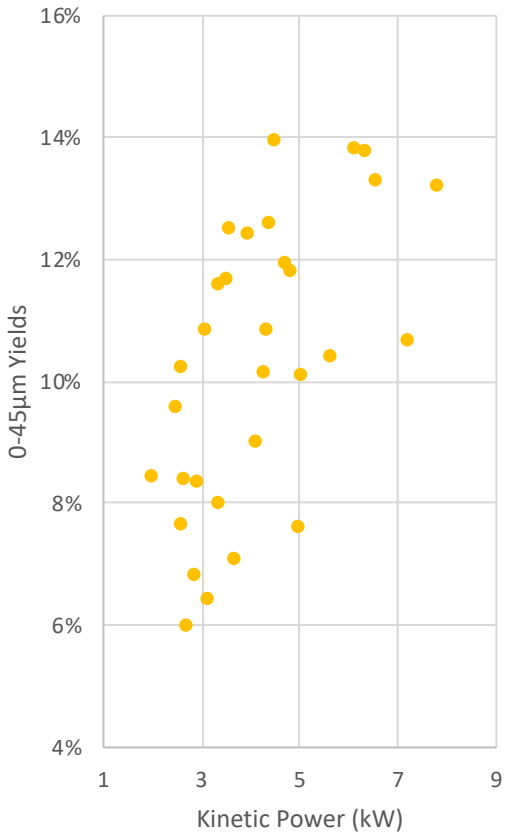
Title	Legend	Average	σ	Min	Max	Correction Equation
Trans (%)		71.0	22.148	9.4	97.7	---
Dv(10) (um)		17.52	17.495	2.75	72.27	---
Dv(50) (um)		58.34	36.055	6.53	158.44	---
Dv(90) (um)		147.80	44.533	11.73	213.39	---

57 Records Averaged

GAS EFFICIENCY







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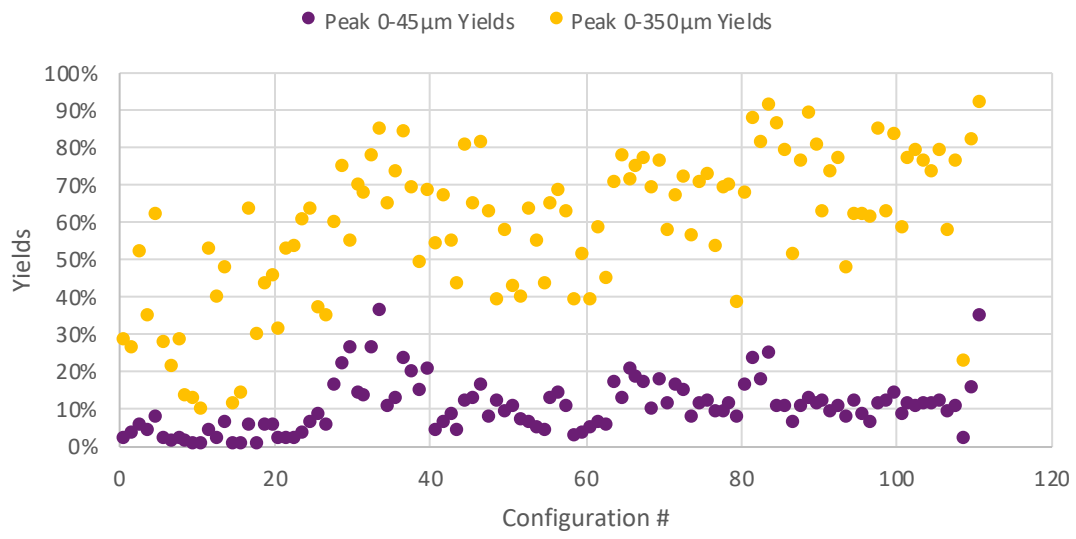
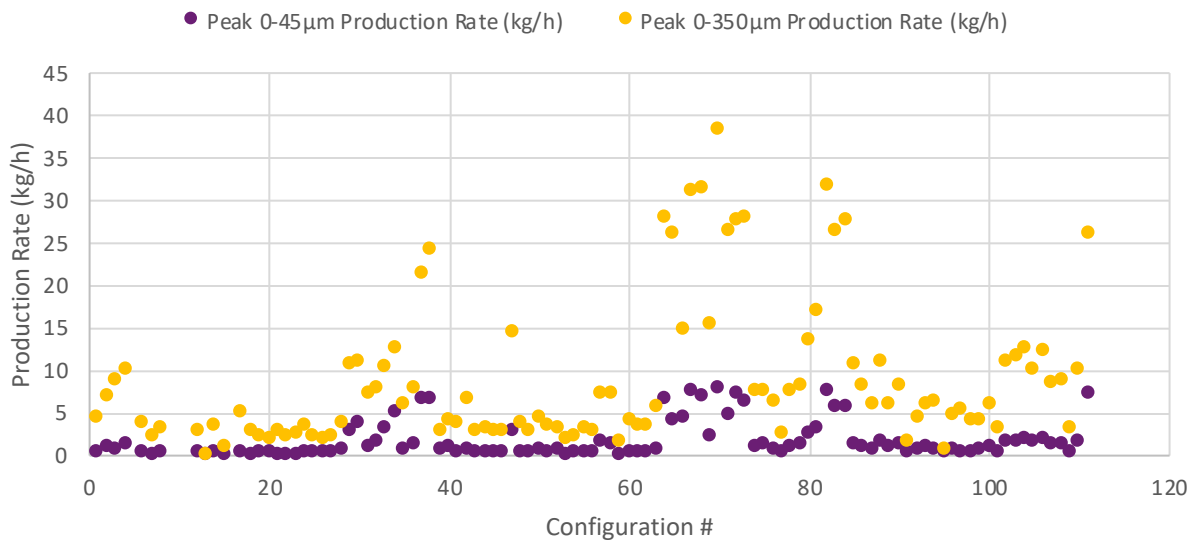
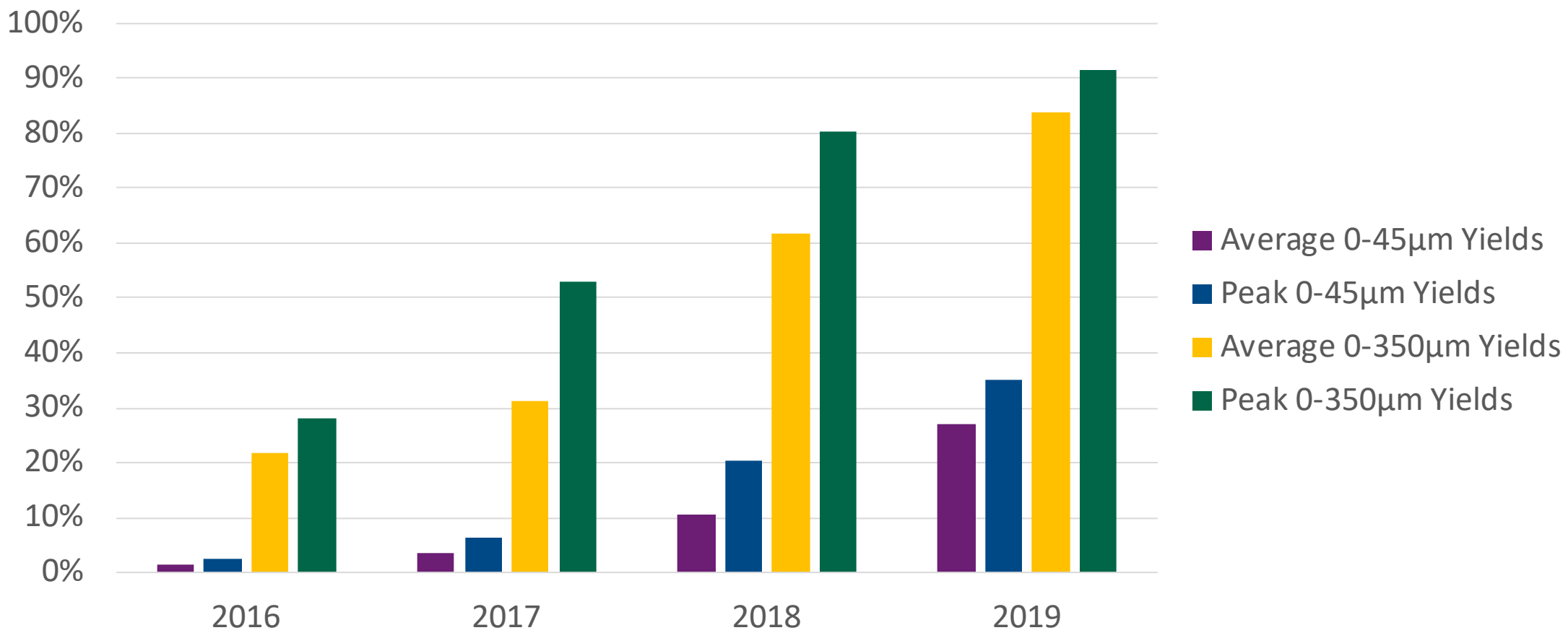
YIELDS AND THROUGHPUT





Material	0-45µm Yields	0-350µm Yields	0-45µm Production Rate (kg/h)	0-350µm Production Rate (kg/h)	0-45µm Production Rate (lb/h)	0-350µm Production Rate (lb/h)
RHA Steel	35.2%	91.7%	7.4	26.1	16.3	57.6
17-4 Stainless Steel	20.9%	71.2%	4.4	14.8	9.6	32.6
Aluminum	26.2%	54.8%	3.9	10.9	8.5	24.0
AlAg	26.3%	77.6%	3.2	10.6	7.0	23.4
AlAgCu	36.5%	84.6%	5.0	12.6	11.0	27.7
Ti 6-4	16.4%	84.5%	2.0	12.6	4.4	27.8
Ti 10-2-3	20.4%	68.4%	0.9	4.0	2.0	8.8
Ti 5-5-5-3	16.0%	89.0%	2.8	14.4	6.1	31.9
TiNb	10.6%	64.5%	0.7	5.9	1.5	12.9
Inconel 718	24.7%	91.5%	8.0	38.4	17.6	84.7
Haynes 230	16.4%	67.9%	3.0	17.1	6.7	37.7

YIELDS BY YEAR



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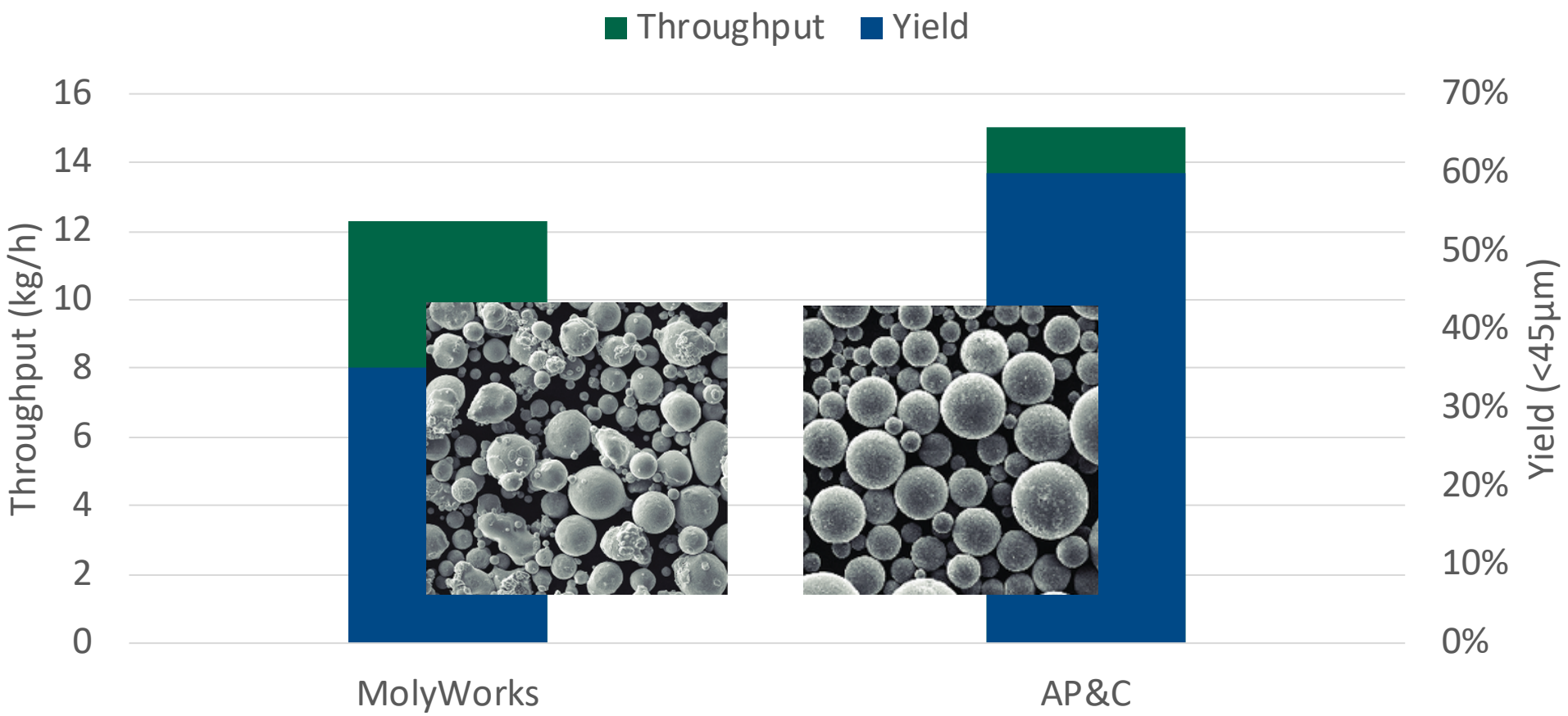
INDUSTRY COMPARISON



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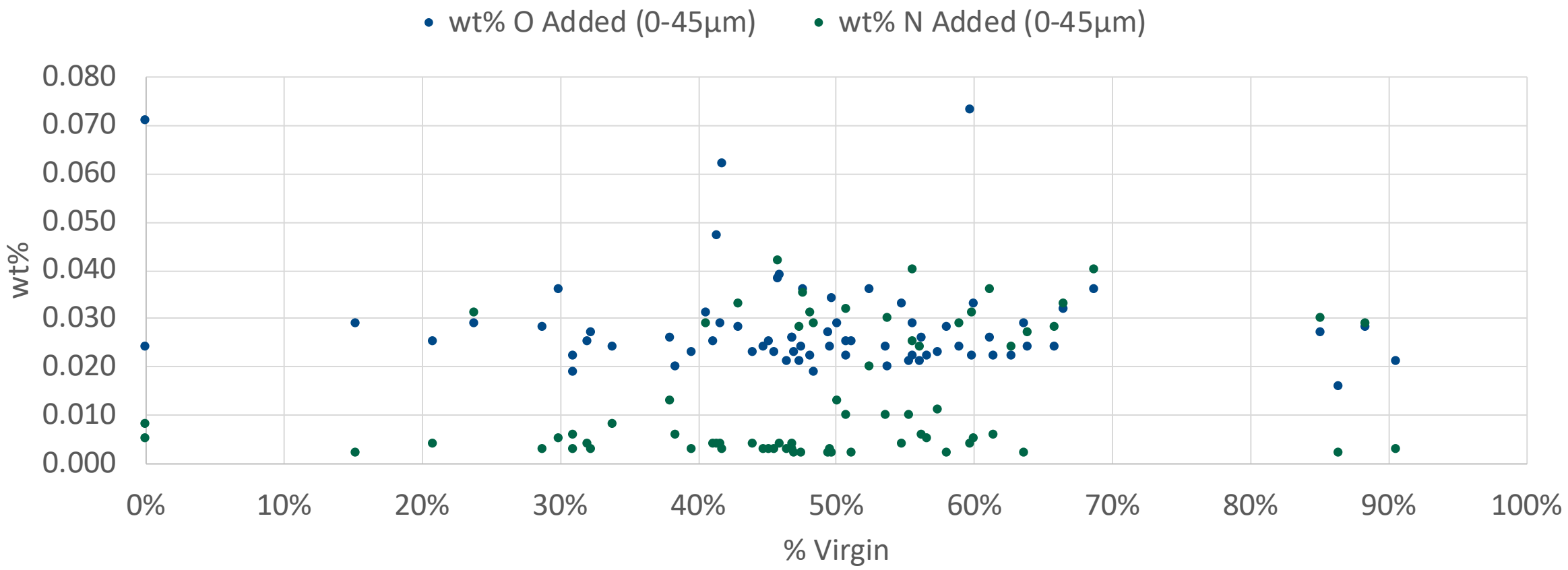
OXYGEN CONTROL



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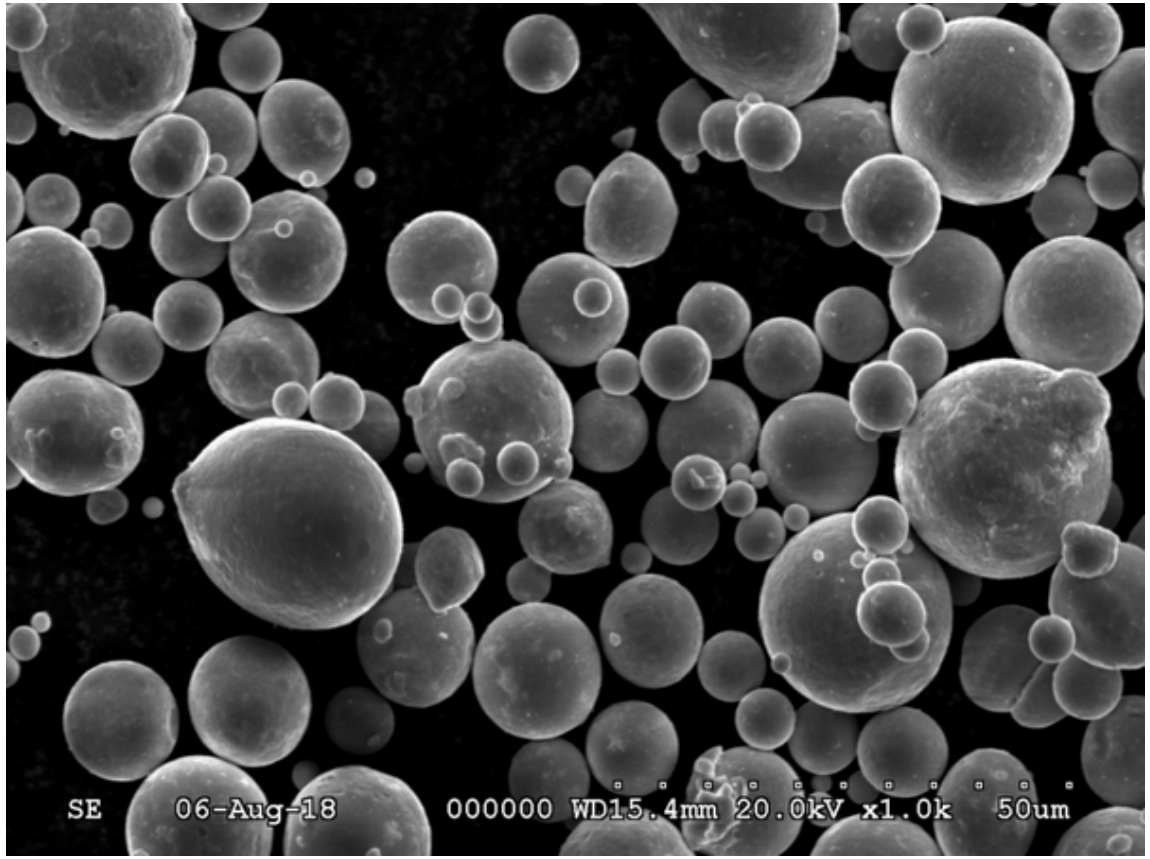
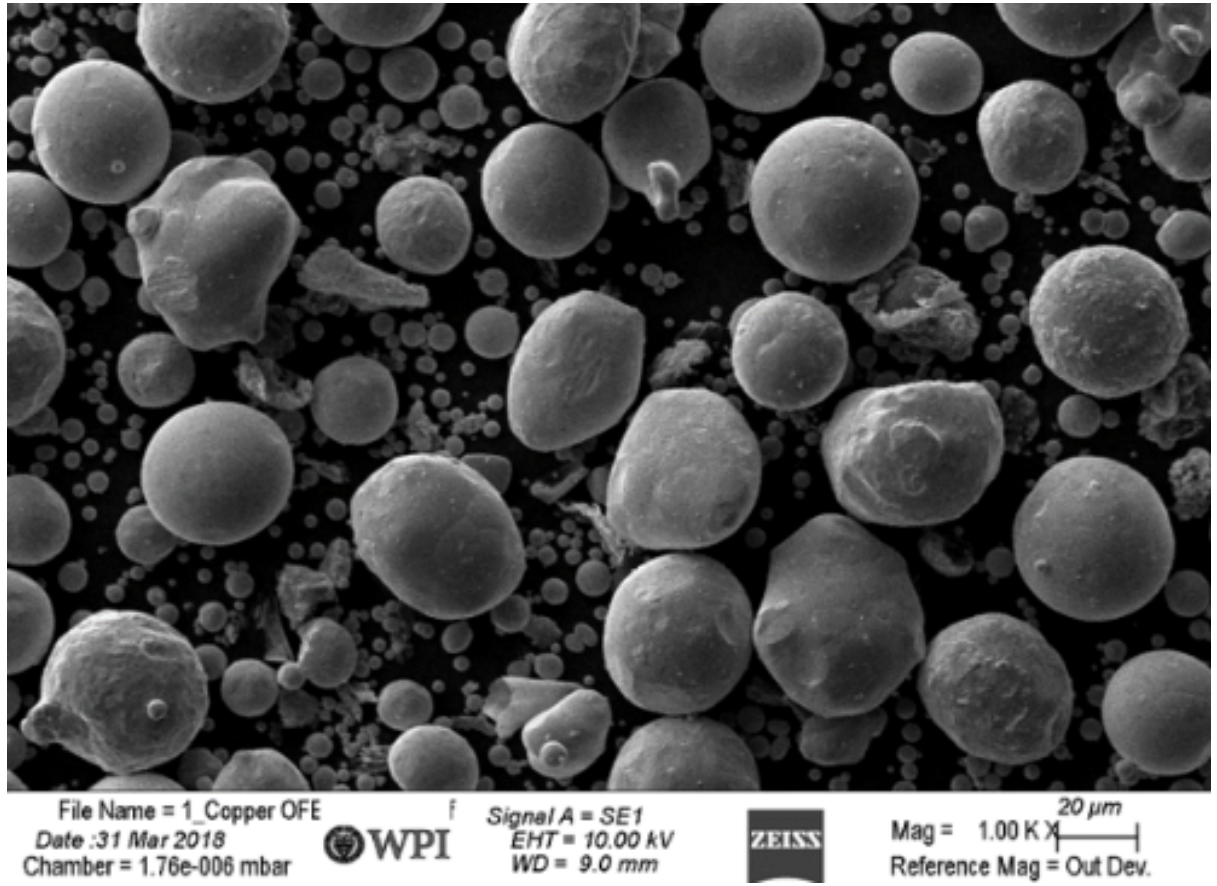
MORPHOLOGY





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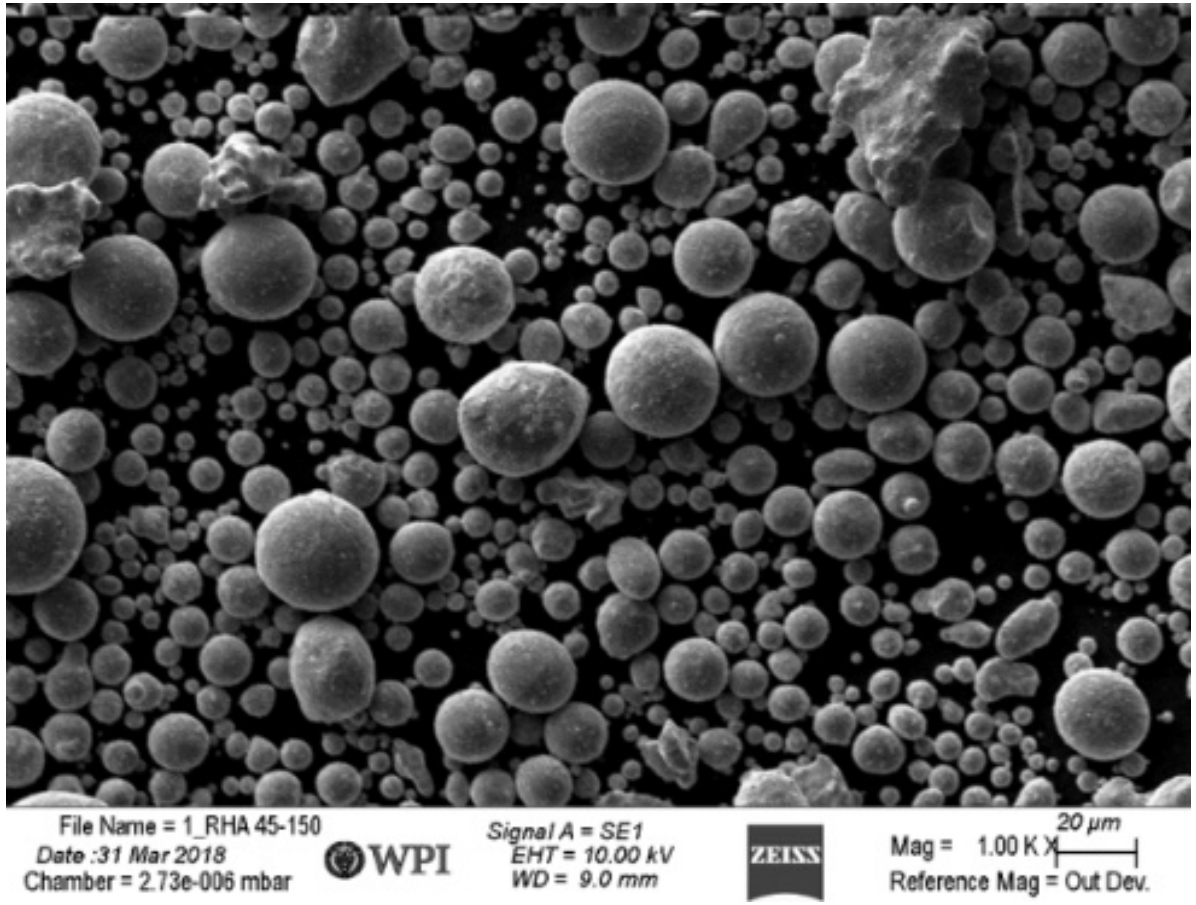
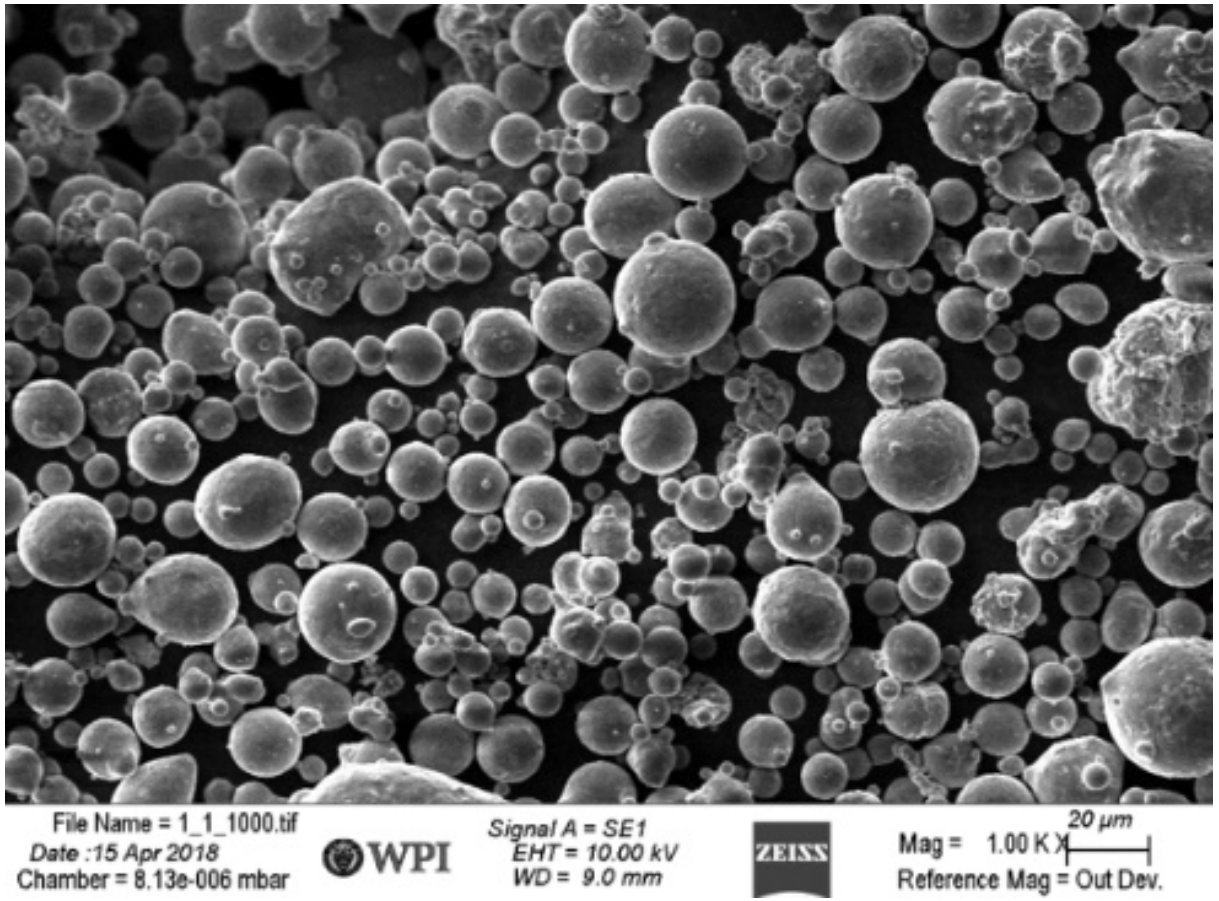
MORPHOLOGY





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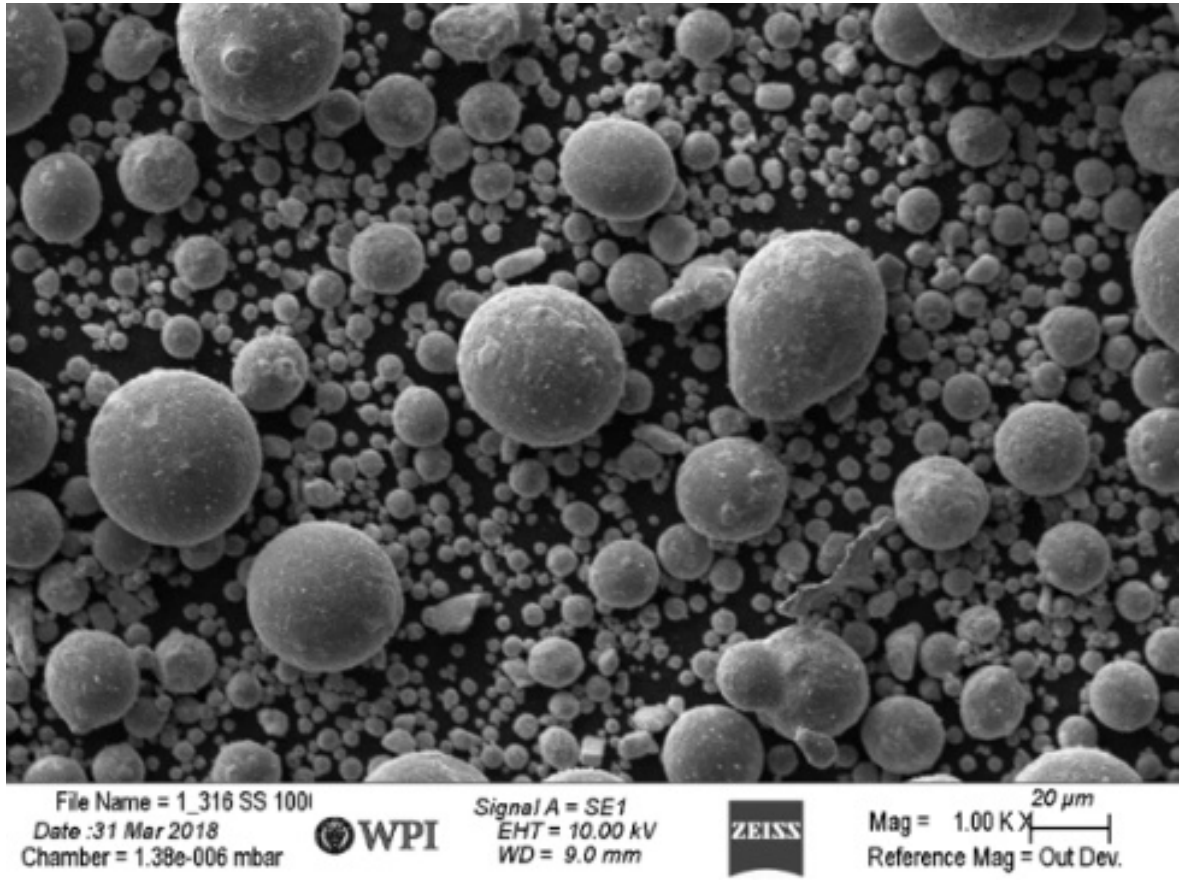
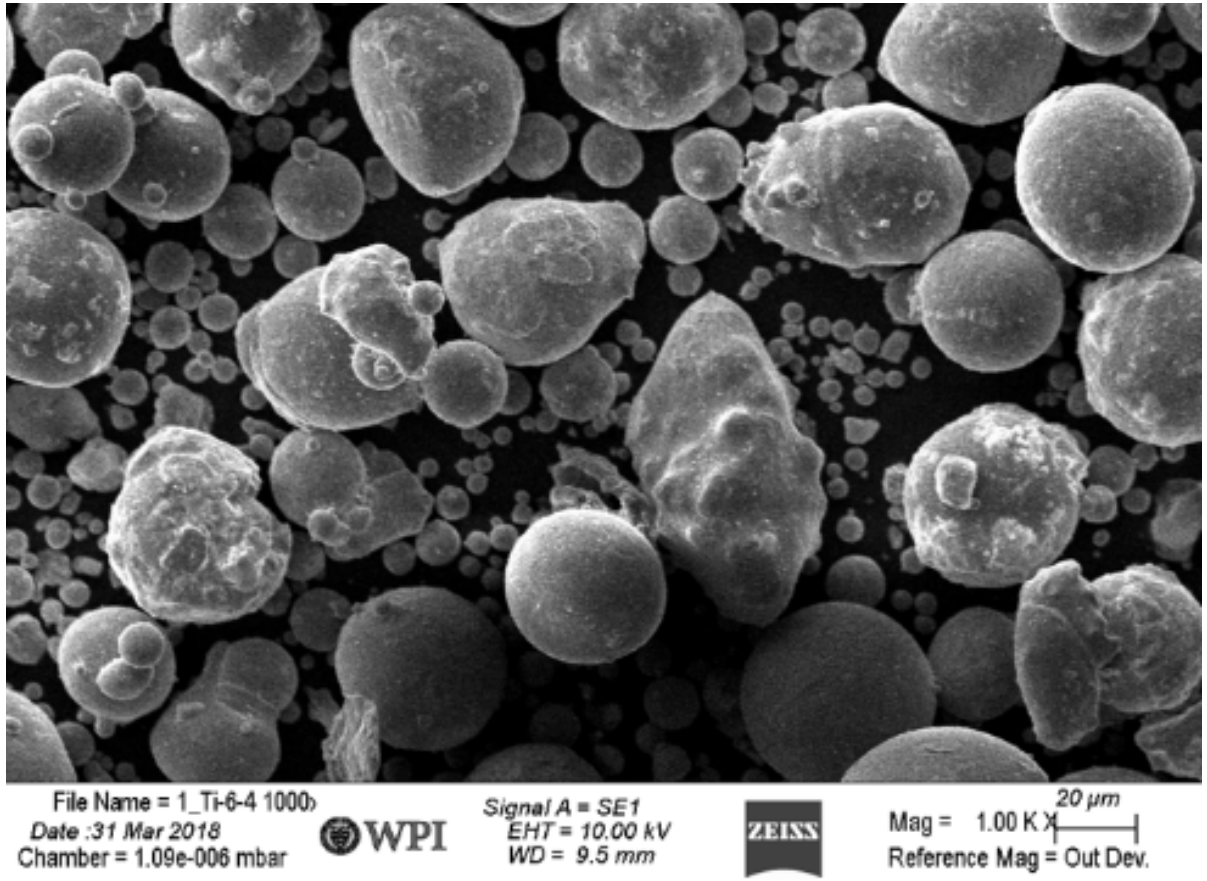
MORPHOLOGY





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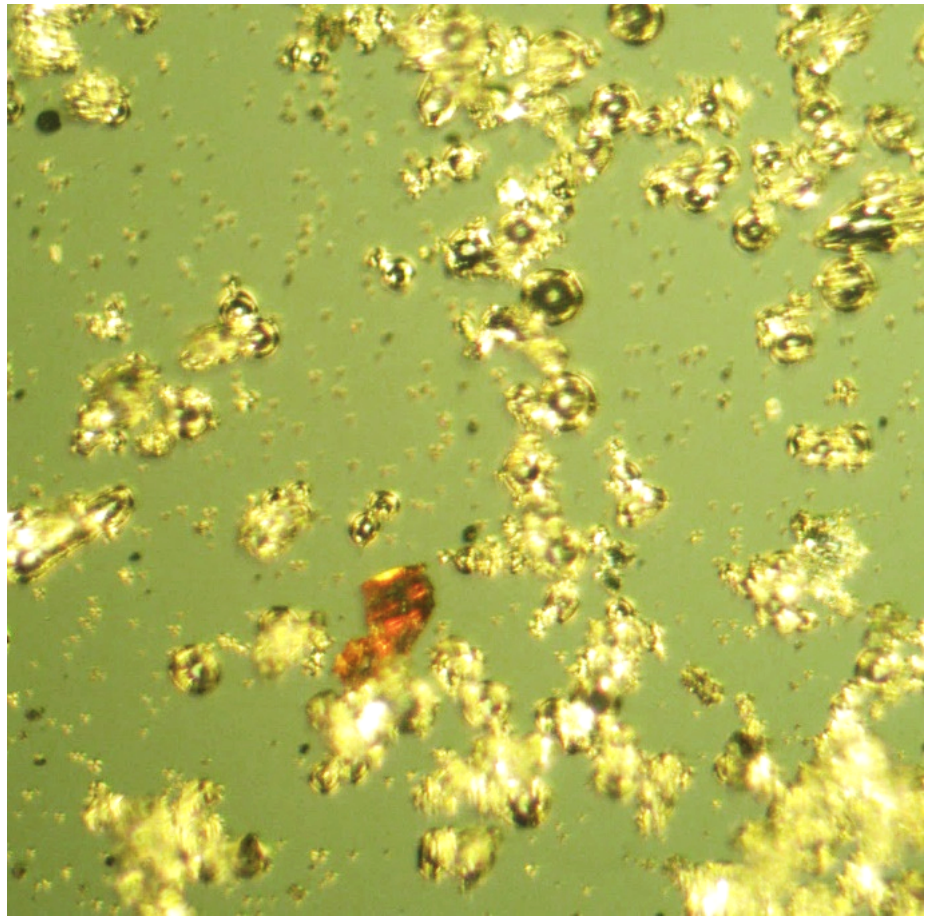
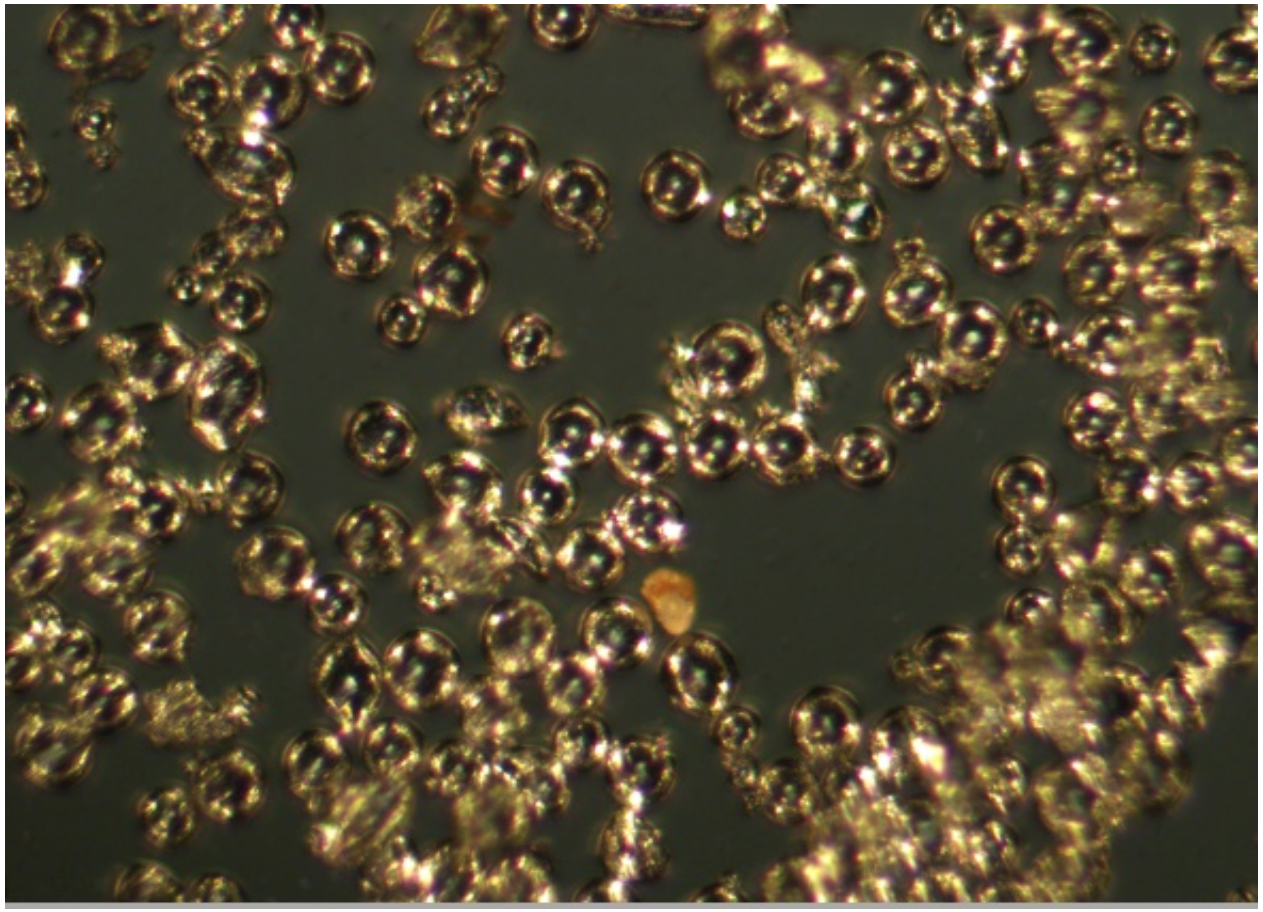
CONTAMINATION DETECTION





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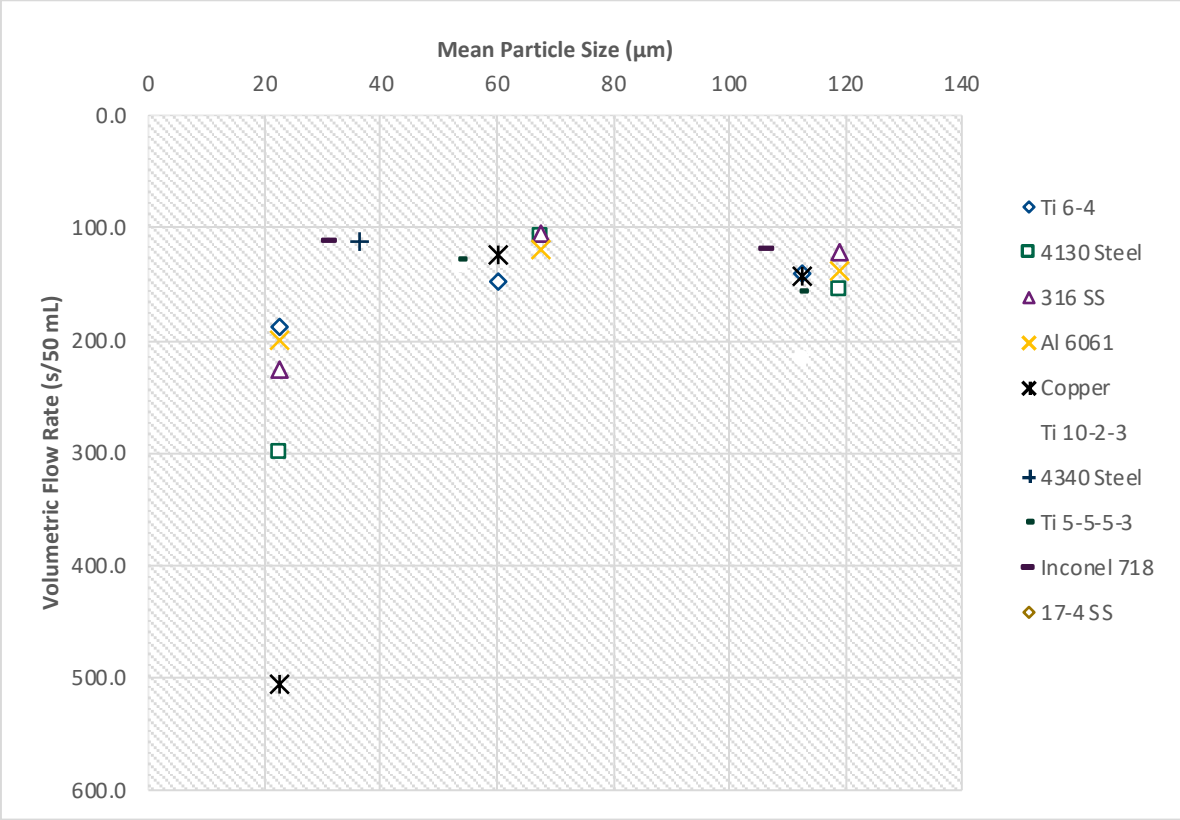
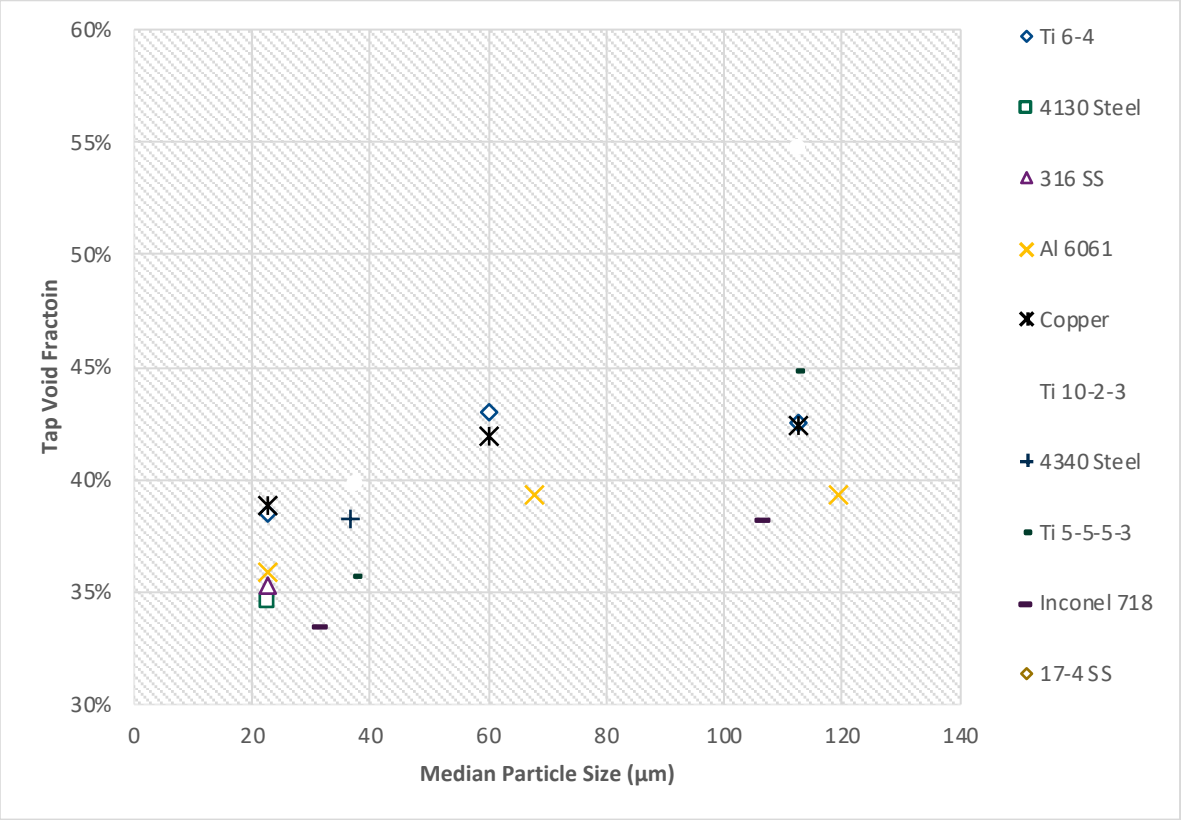
FLOWABILITY





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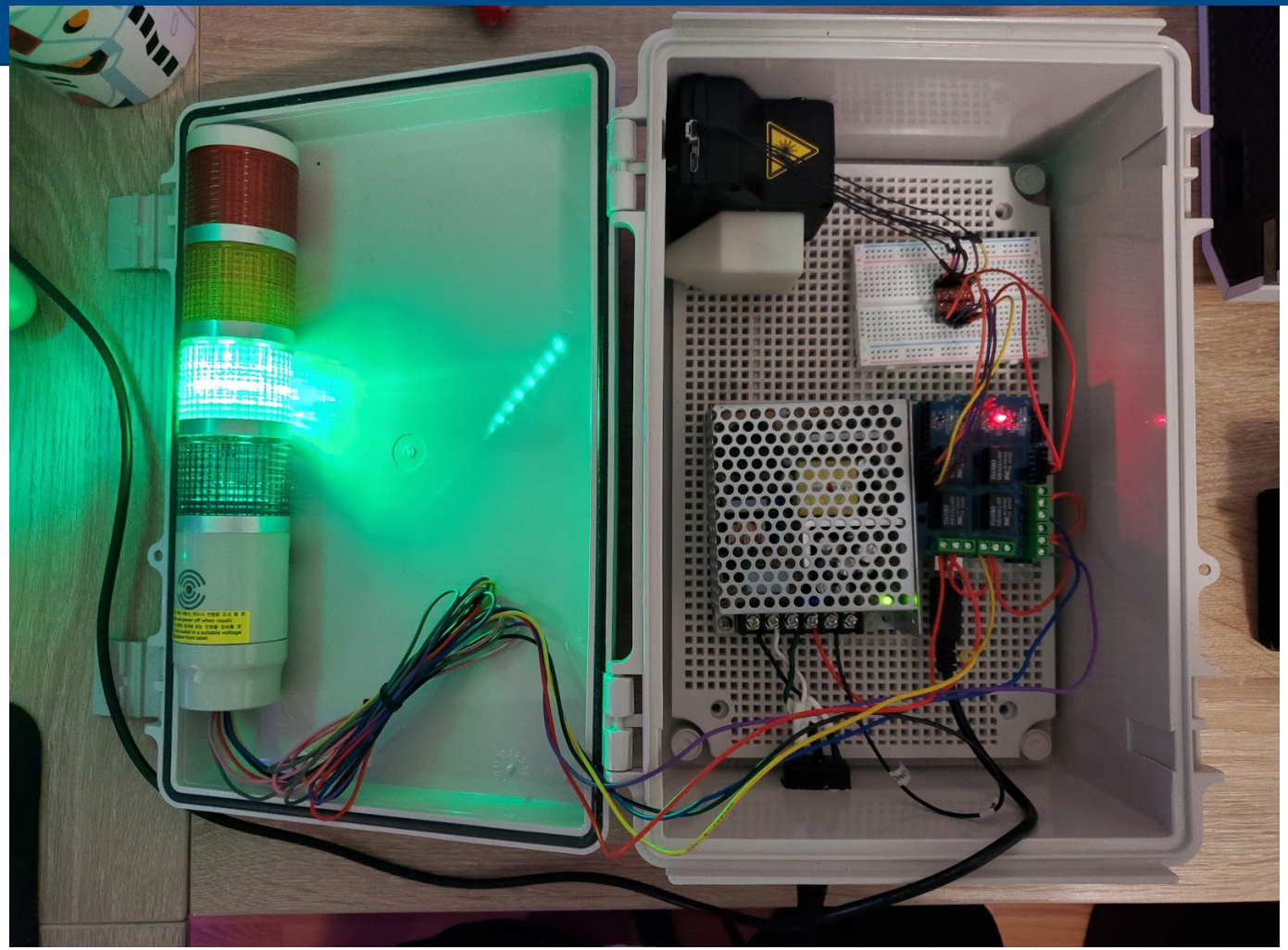
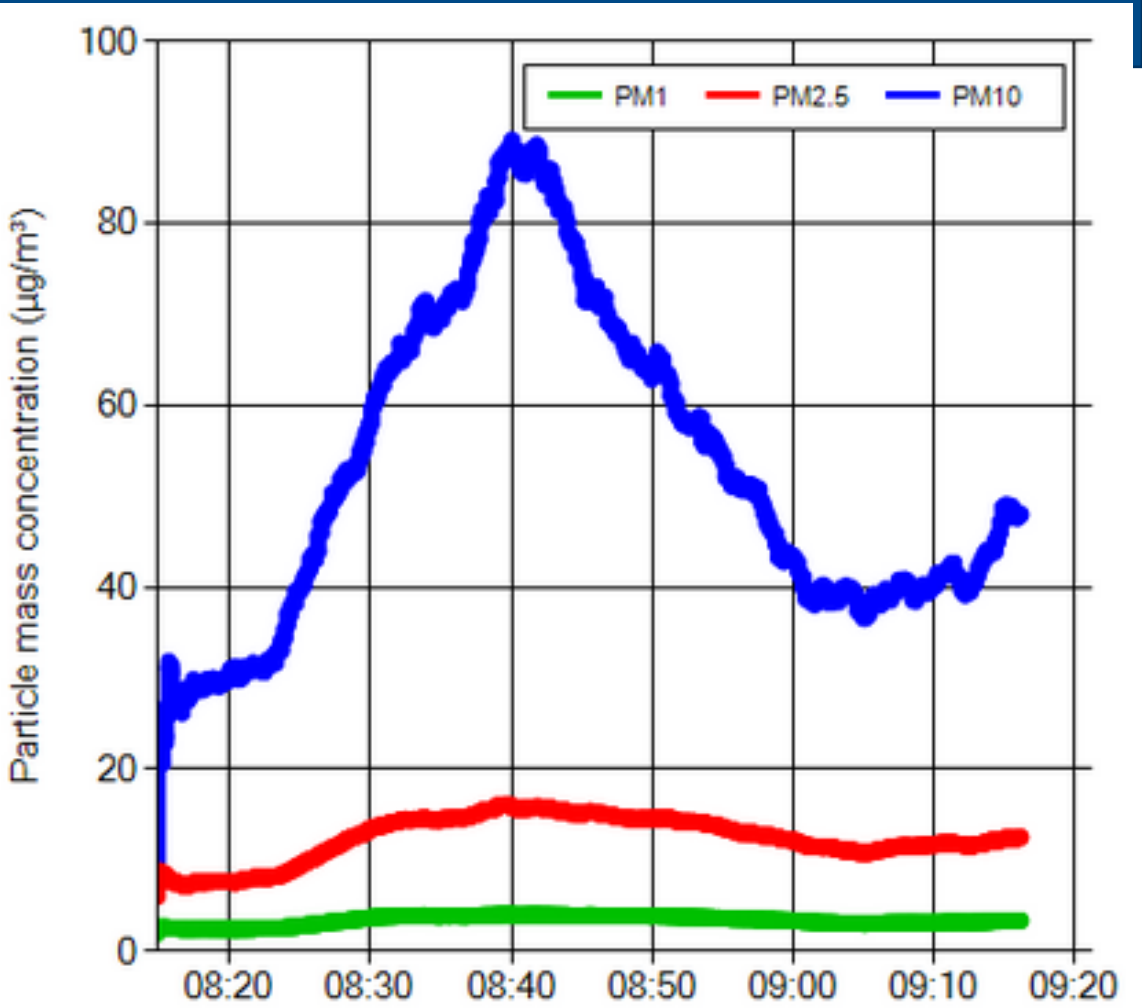
SAFETY -- AIR PARTICULATE MONITORING





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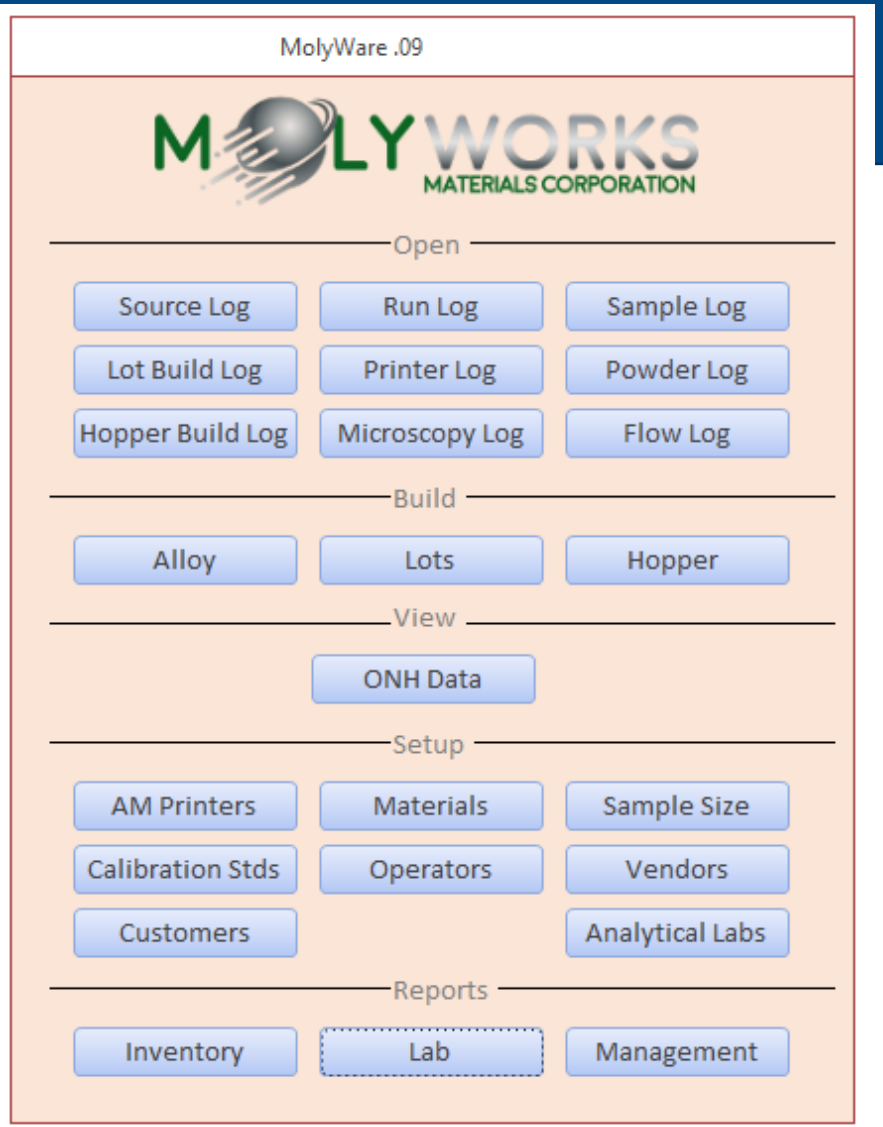
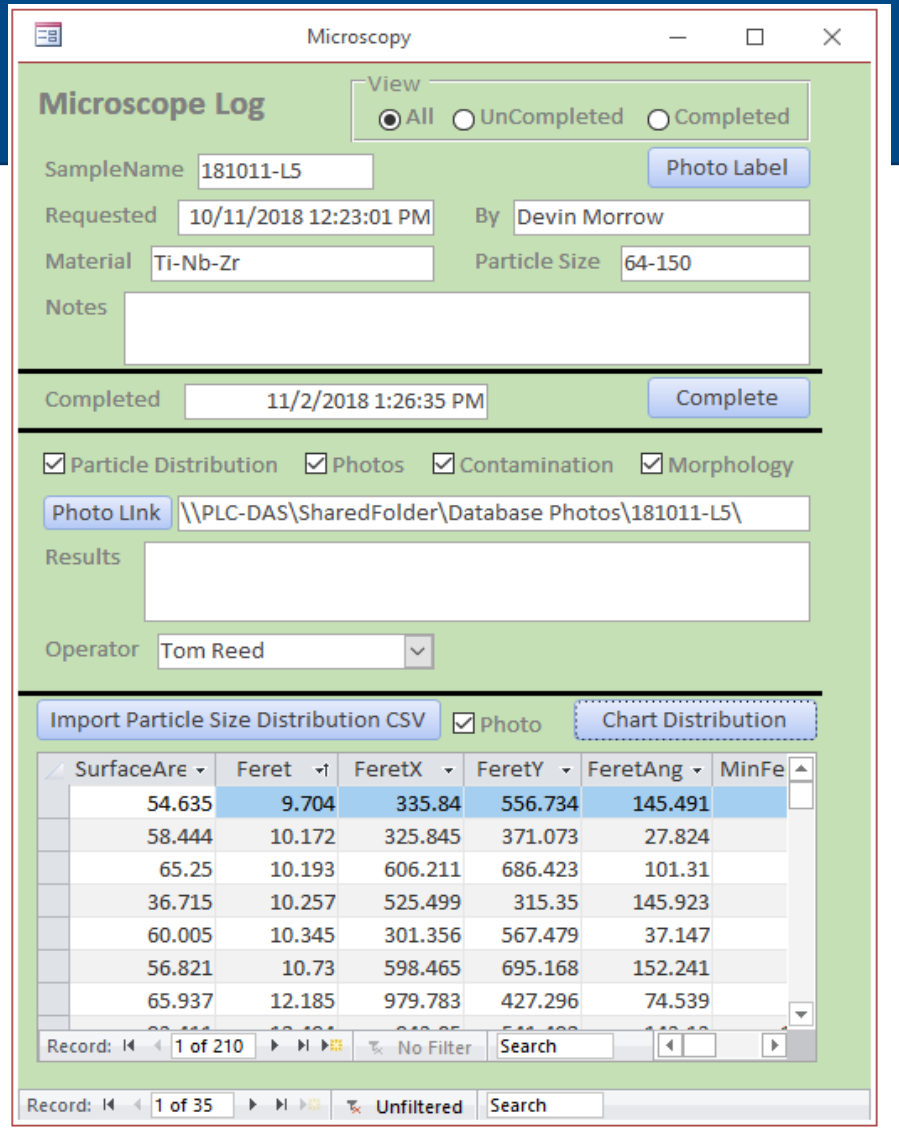
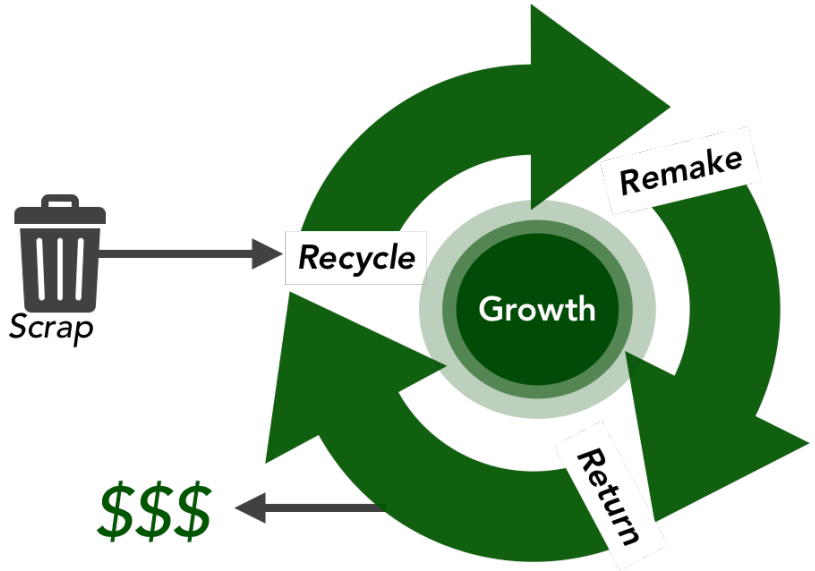
TRACEABILITY





Company Information:

- Molyworks Materials Corporation
- Founded in 2015
- Located in Cloverdale, California
- Find us online: www.molyworks.com
- Growing team with 20 employees
- We are seeking to bring distributed recycling to the world by converting metal scrap into additive grade powder, and printing these strategic metals into parts



Technology Information:

- Molyworks is currently converting 100's of kilograms of waste into powder
- Operational TRL 7, with continuous improvement environment in our foundry
- Molyworks offers a distributed recycling model that allows consumers to drive value back into their material supply chain.

CLOSING REMARKS

Ability to Deliver:

- Baseline return of 10% above market scrap value
- Return at sale of atomized powder, or return of atomized powder at 10% cost below market value
- Very strong strategic advisory board
- Partnered with O&G, as well as Aerospace
- Awarded 4 SBIR opportunities in areas of battlefield atomization, custom alloy development, and AM adoption in Air Force landing gear assemblies