The use of ultrasonic atomisation methods to produce PGM and alloy powder for 3D printing at Mintek

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Advanced Materials Division

Physical Metallurgy group

Mintek, Randburg, South Africa

9th International PGM conference, 27-28 October 2025

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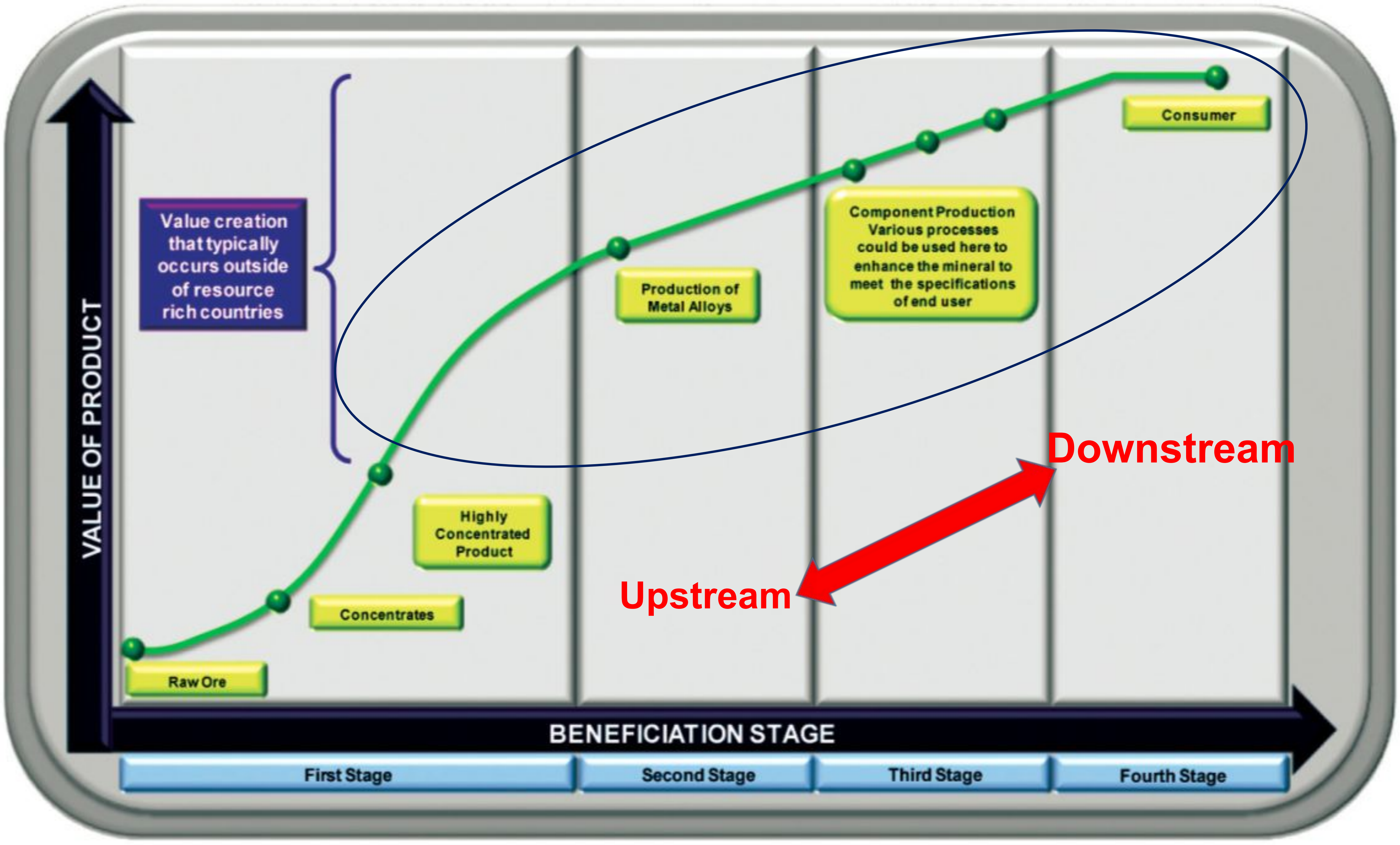

VALUE OF PRODUCT
Value creation that typically occurs outside of resource rich countries
Raw Ore
Concentrates
Highly Concentrated Product
Production of Metal Alloys
Component Production Various processes could be used here to enhance the mineral to meet the specifications of end user
Consumer
Downstream
Upstream
BENEFICIATION STAGE
First Stage
Second Stage
Third Stage
Fourth Stage

Introduction

- Additive manufacturing is one of the key areas that is leading the future of design
- While not replacing any technological method of casting,
- It play important role in producing intricate and knotty designs

✔ Be it in jewellery (intricate designs from hard and HTM material)

❖ the most durable and corrosion resistant material would be hard to roll and craft

✔ Or mechanical engineering complexities (e.g. implant design, porous structures, heat exchangers, etc)

 This is where metal 3D printing become invaluable

❑ Challenge is availability of powder with desired particle size distribution and local production

❑ In case where powder is attained, recycling of used powder, failed prints and any scrap metal become a challenge

 Mintek has invested in *Amazemet rePowder* system and *concept laser (LPBF)* metal 3D printer

Introduction

- **We present capabilities at Mintek in:**

❖ **Alloying**

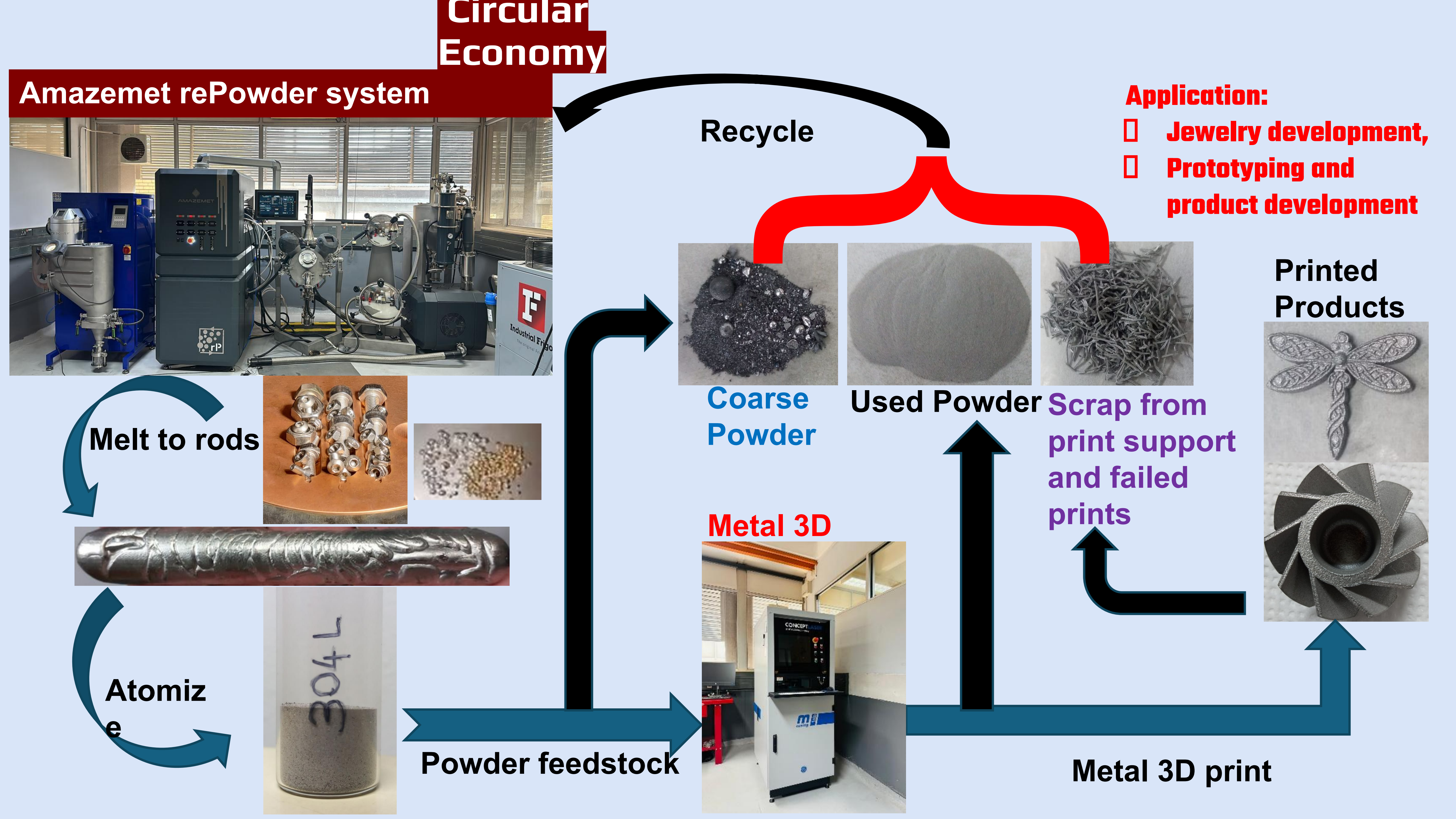
❖ **Powder production and**

- **Present an example of how the system can produce readily alloyed powder particles**

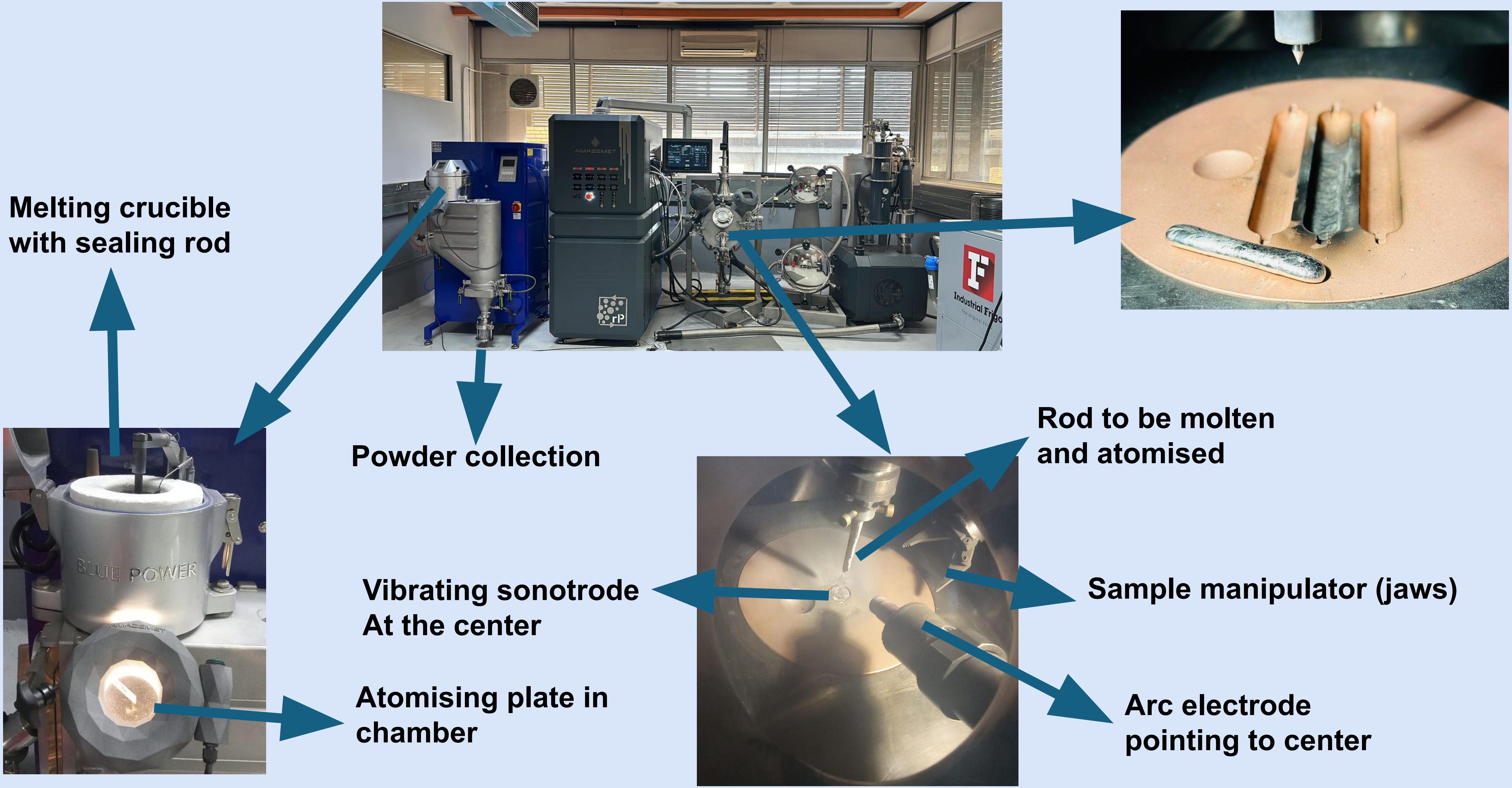
 Thus, proving important technological input for metal alloy additive manufacturing (3D printing)

 with freedom of design, reduction of waste, rapid prototyping, sustainability,

And contributing to 5th Industrial revolution


Circular Economy
Amazemet rePowder system
Recycle
Application:
Jewelry development,
Prototyping and product development
Printed Products
Melt to rods
Coarse Powder
Used Powder
Scrap from print support and failed prints
Metal 3D
Atomiz
e
304L
Powder feedstock
Metal 3D print

Melting and Atomisation Technique and Equipment



Approach to this paper:

- **Come up with Atomisation parameters using the Amazemet system:**

- **Melting process**

- **Atomisation process**

- **We start by showing atomized 304L steel wire**

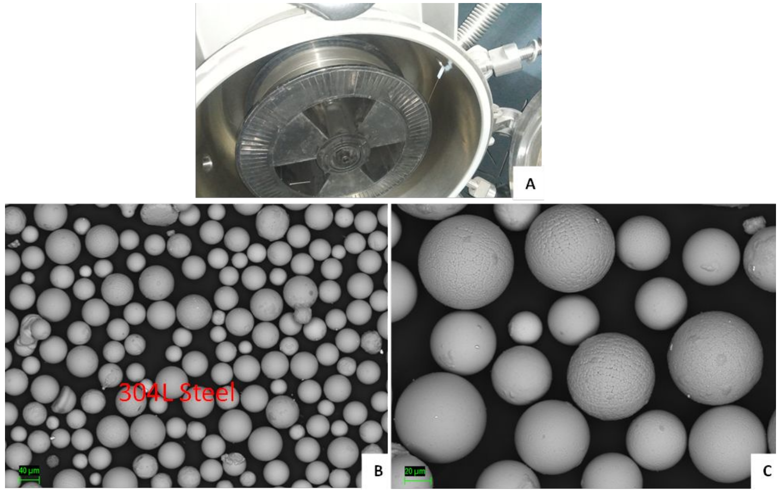
- **Then recycled Ti-Al scrap powder**

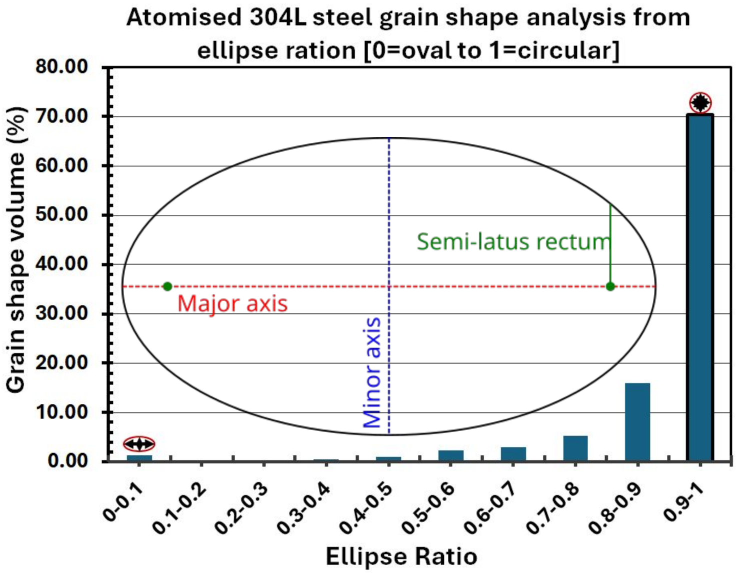
- **Atomisation of pure Pt**

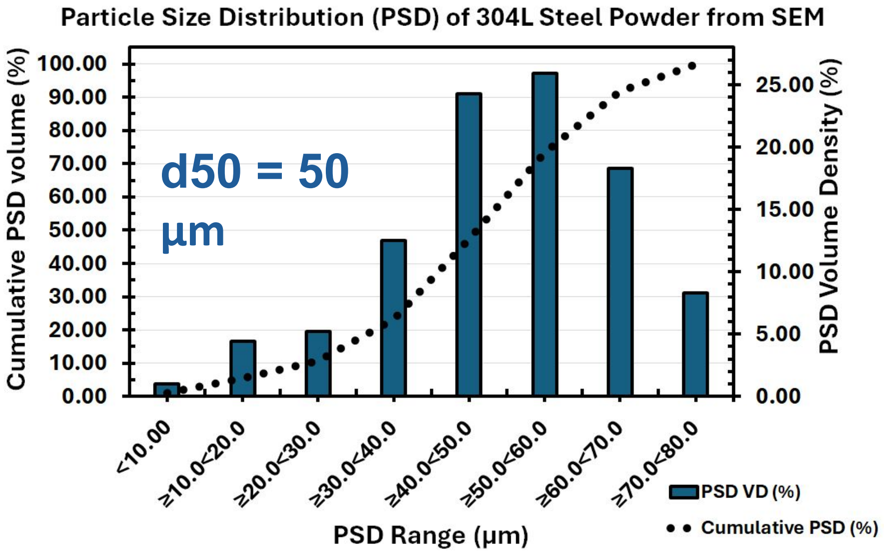
- **And 3D printing of the atomized Pt**

304L Steel wire

	Fe	Si (Wt.%)	Cr (Wt.%)	Ni (Wt.%)
Overall	Balance	0.7 ± 0.03	18.7 ± 0.01	10.0 ± 0.10



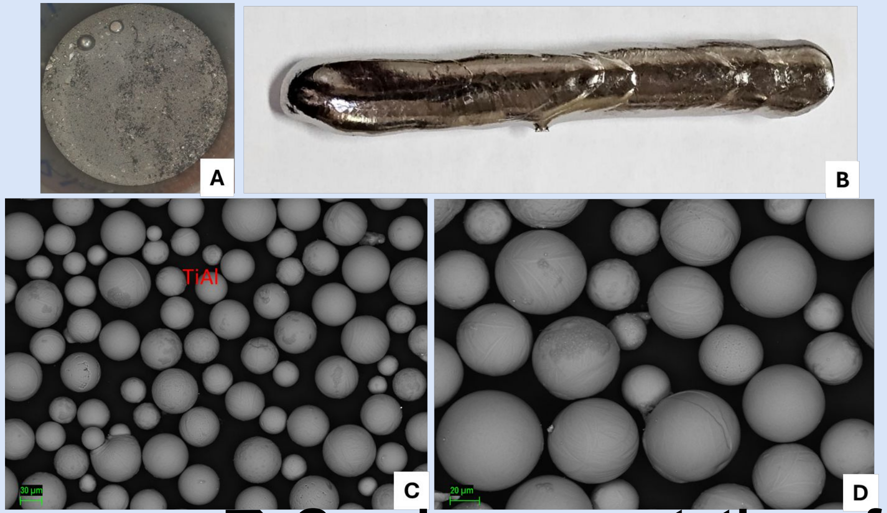


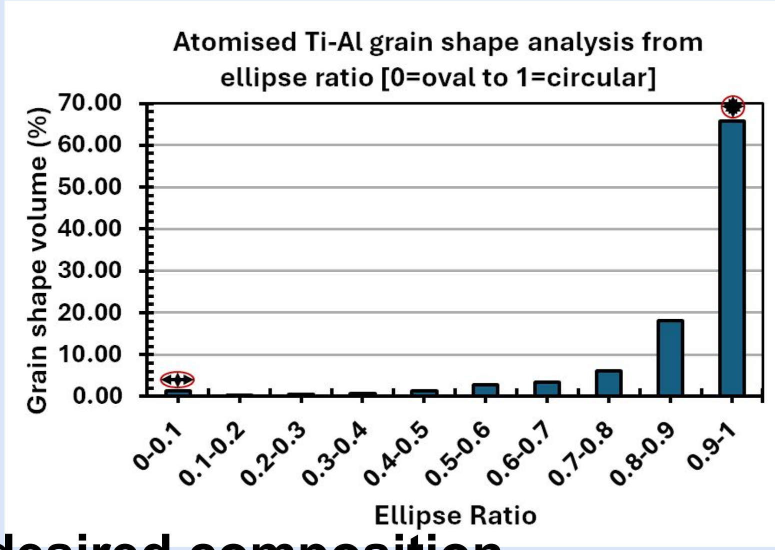


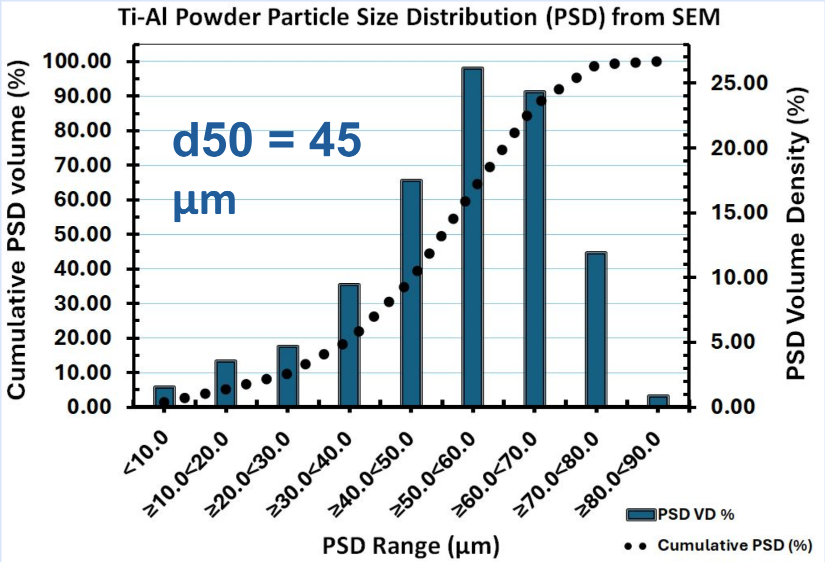
- Good representation of desired composition
- Ellipse ratio a/b (semi-minor axis to the semi-major axis), a 1:1 ratio is a circle
- 70% of particles are 90-100 % spherical
- d90 = 65 µm, d50 = 50 µm. Most of the powder is between 30 µm and 65 µm
- Particle size distribution suitable for LPBF/ SLM printers

Recycled Ti-Al scrap

	Ti (Wt.%)	Al (Wt.%)
Overall	97.80 ± 0.17	2.20 ± 0.17

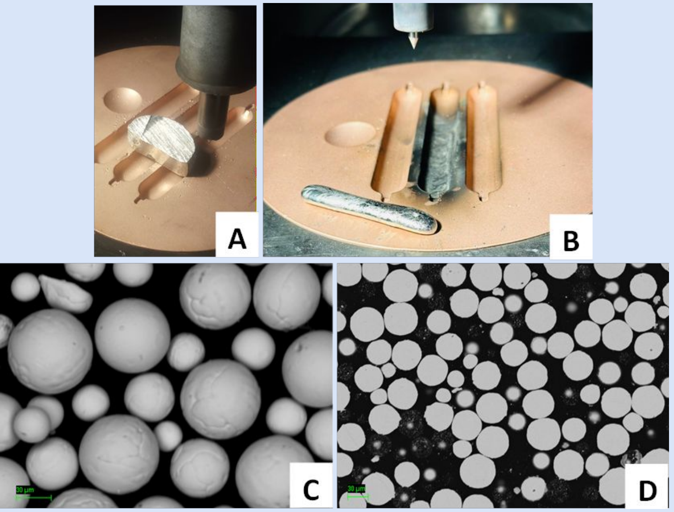


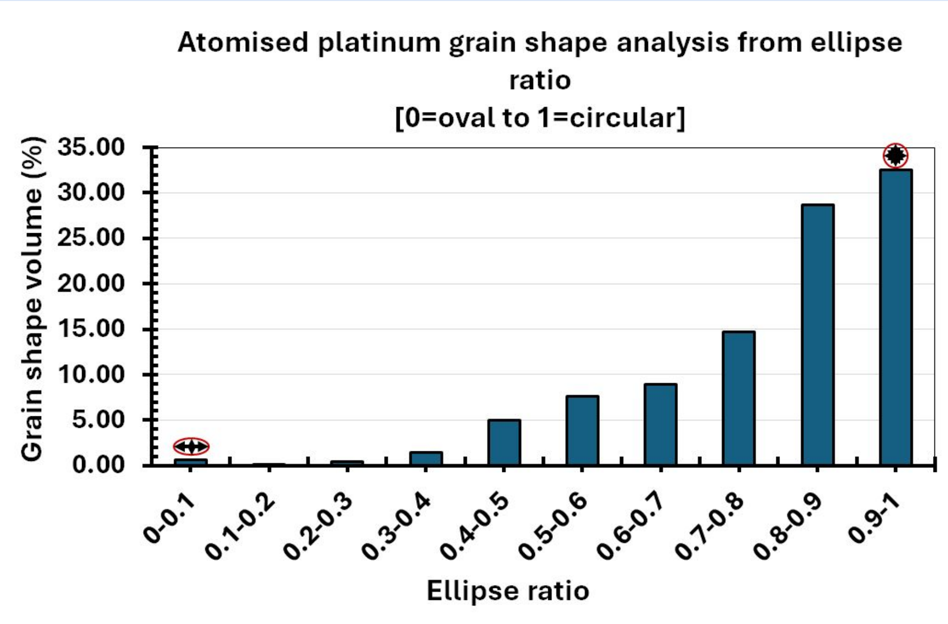


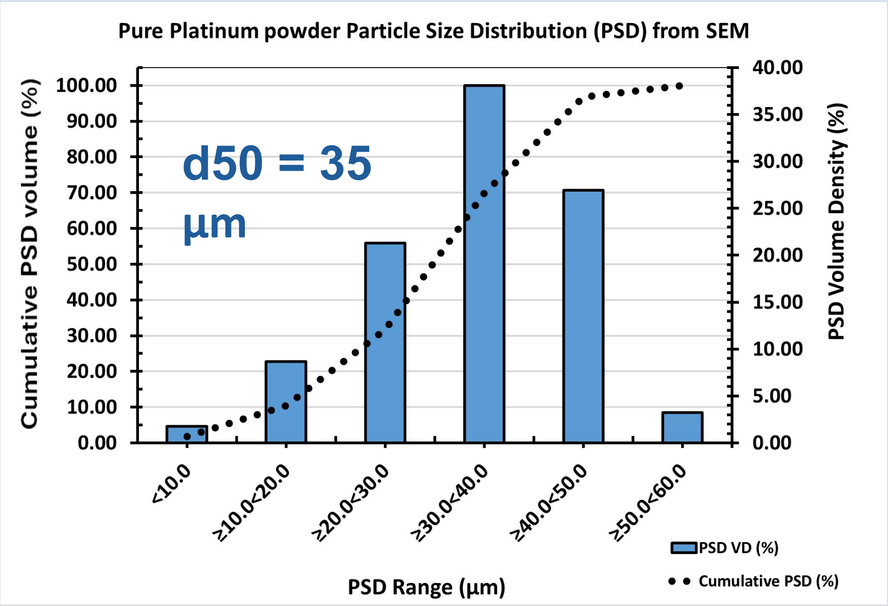


- Good representation of desired composition
- Ellipse ratio a/b (semi-minor axis to the semi-major axis), a 1:1 ratio is a circle
- +65% of particles are 90-100% spherical
- d90 = 70 µm, d50 = 45 µm. Most of the powder size is below 70 µm
- Particle size distribution suitable for LPBF/ SLM printers

Pure Platinum atomization

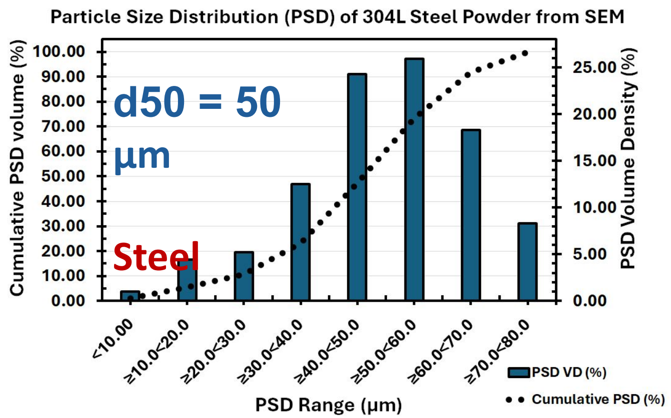


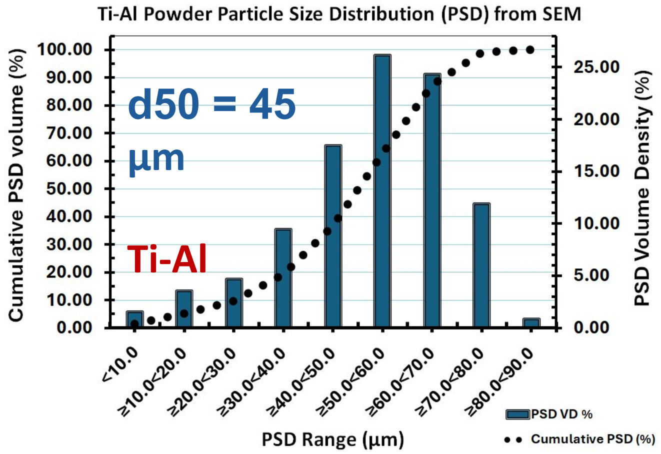


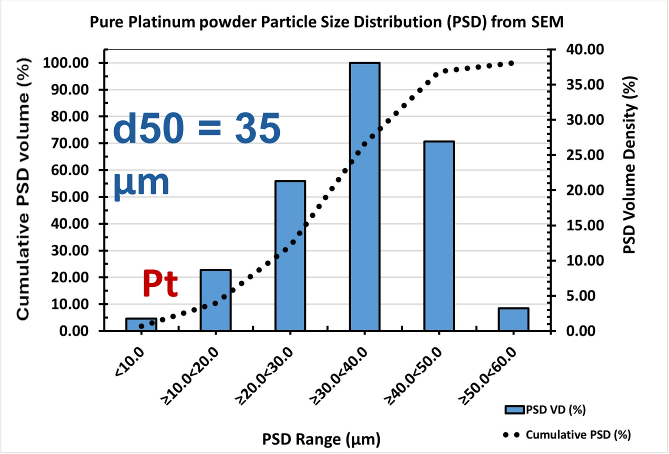


- ❑ Pt particle size distribution comes out in range different from less dance material (steel and Ti)
- ❑ Ellipse ratio a/b (semi-minor axis to the semi-major axis), a 1:1 ratio is a sphere
- ❑ Wide range of spherical distribution compared to steel and Ti (more than 75% has ellipse ratio >0.7)
- ❑ Narrow PSD: d50 = 35µm and d90 = 40 µm. Narrow PSD < 60 µm
- ❑ Particle size distribution suitable for LPBF/ SLM printers

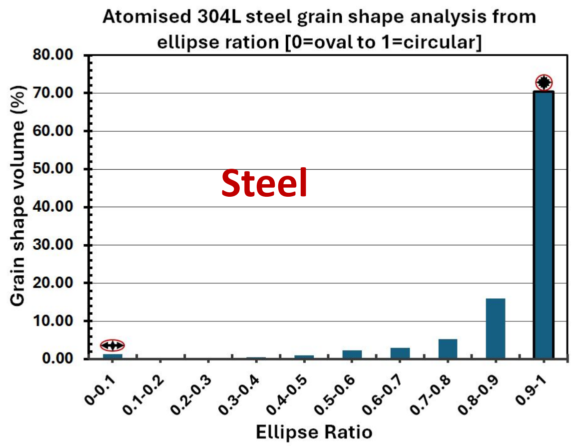
Discussion

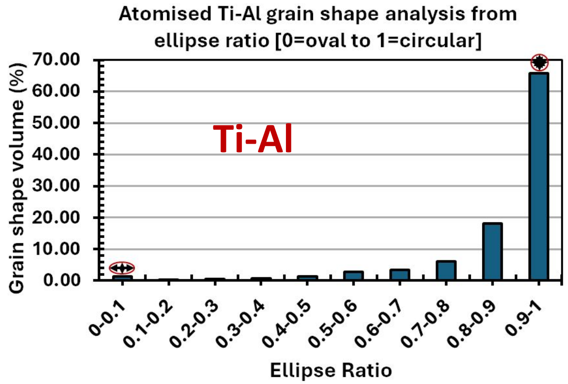


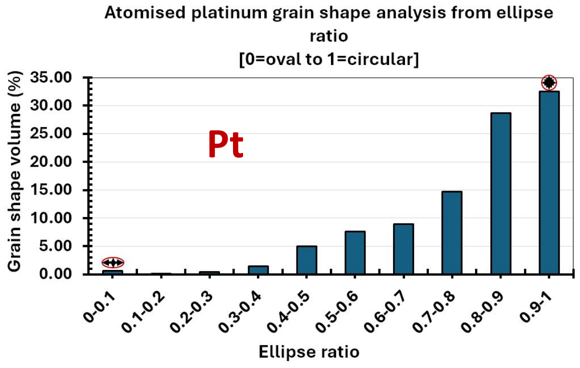




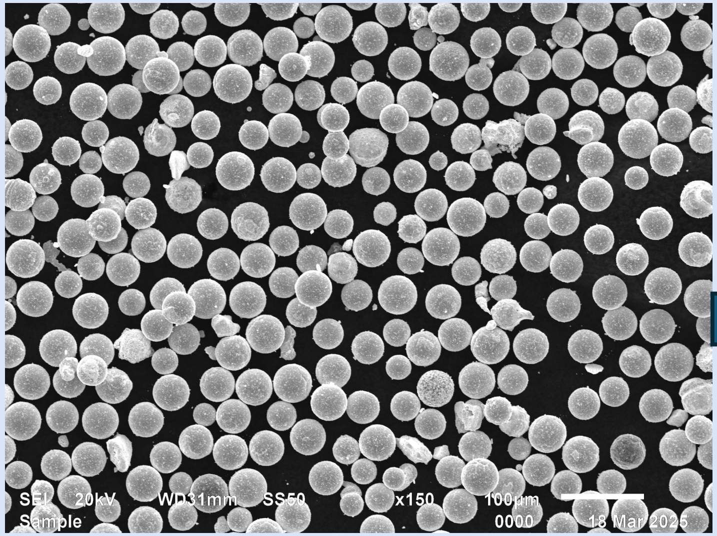
- ❑ Similar parameters used to melt and atomise except temperature range
- ❑ Density of material plays a role in final product
- ❑ 40 kHz system used produced d50 = 35 – 50 µm
- ❑ Pt has narrower PSD though used same sieve size
- ❑ Pt has a wide ellipse ratio compared to other material but still flows well when printing
- ❑ Particle size distribution suitable for LPBF/ SLM printers





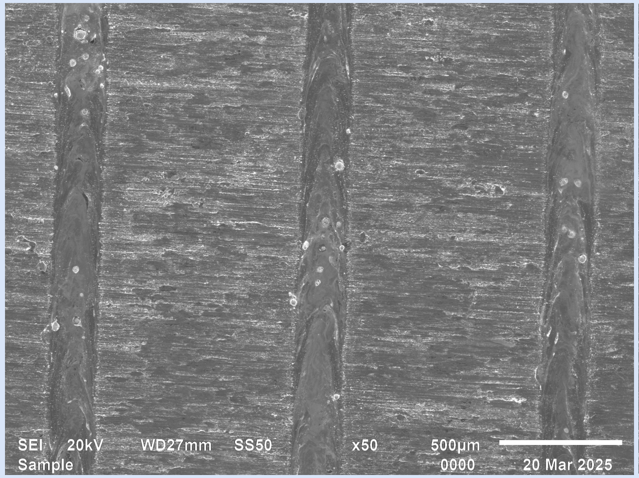


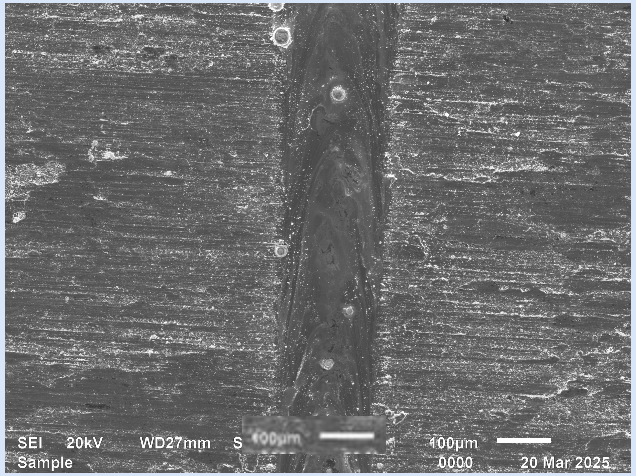
SLM 3D Printed pure Pt cuboids and single tracks



- Pt SLM 3D Printed cuboids and single tracks at CUT

- PSD < 75 µm





- SEM images of single track print from pure platinum showing continuous print
- And good flow of powder, with PSD < 75 µm

Conclusion – Work in Progress

- **Melting and atomization parameters for base metals and PGM well set**
- **The alloying and atomizing system is able to give powder of require PSD (25-75µm) and spherical (will flow), thus suitable for LPBF 3D printer**
- **This is a good platform to proceed with alloy production for either jewellery application or shape memory alloy 3D printed products**
- **Spherical particles up to 70/75 µm do flow (less % above 65 µm)**
- **Continue to optimize parameters for better yield of useful powder**
- **Atomise high melting temperature alloy and characterize**
- **Use 20 kHz system on Pt and print**

20 kHz produce d50 = 60 – 100 µm and 40 kHz gives d50 = 45 – 60- µm

- **Production of more specialized alloy powders for PGM beneficiation with academic and industry collaborators in ZA**

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ami
advanced metals initiative

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CHPC
CENTRE FOR HIGH PERFORMANCE COMPUTING

Mintek-AMD Additive Manufacturing Lab

THANK YOU

Outline

- Introduction
- Objectives
- Method and material description
- Results and discussion
- Conclusion
- acknowledgement