Powder production of pre-alloyed platinum alloys for jewellery applications

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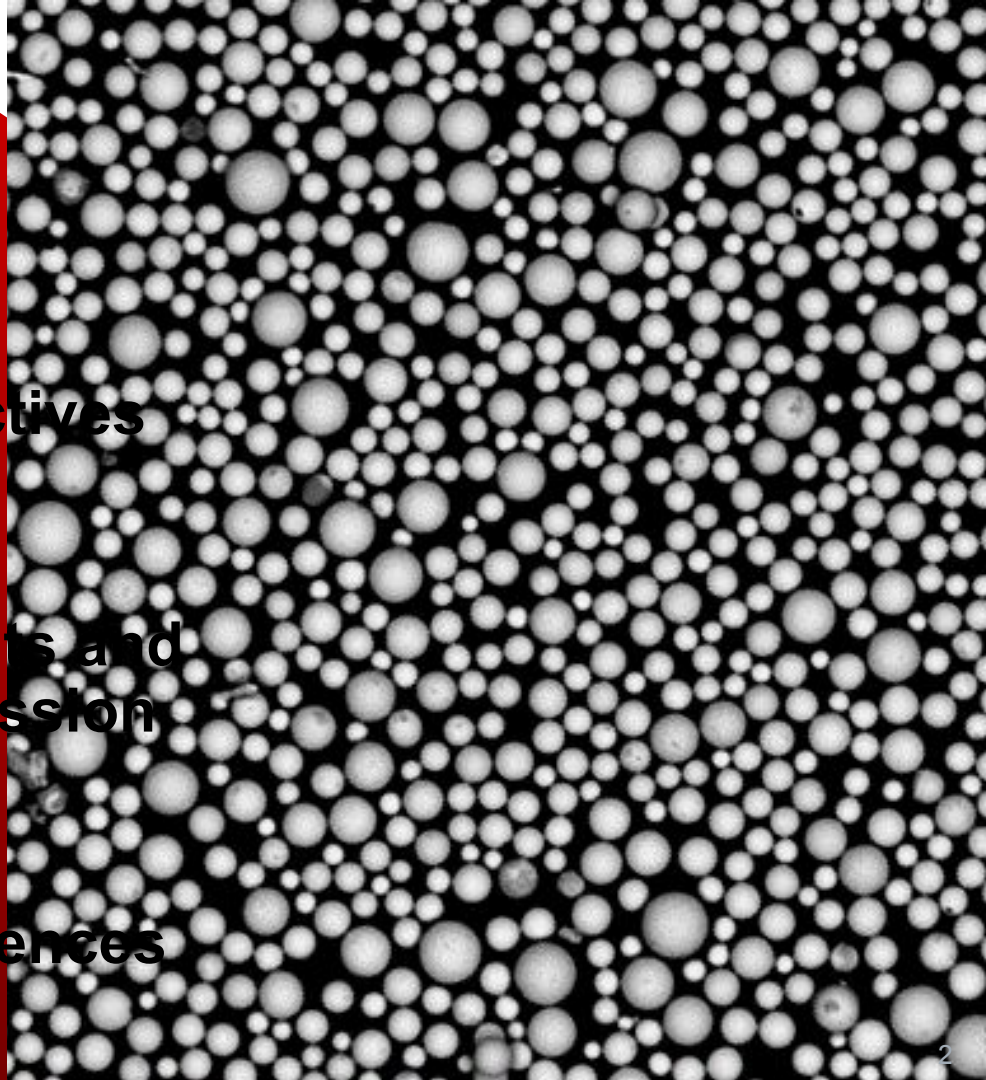
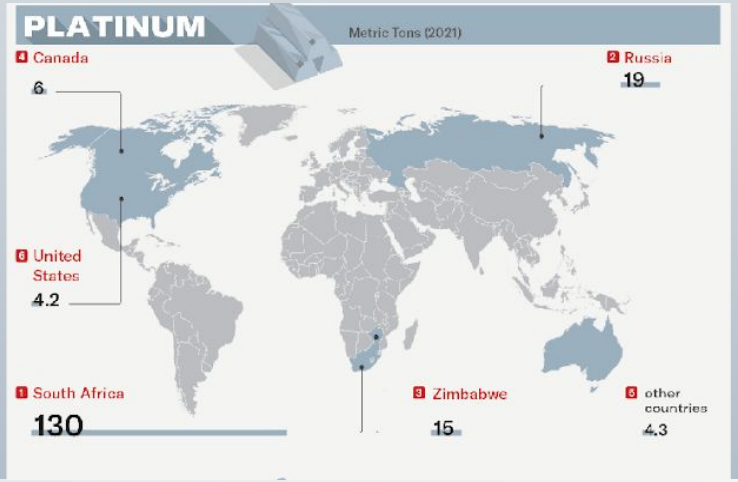


Introduction

- Renewed interest in the platinum (Pt) jewellery industry.
- Advancements in additive manufacturing (AM) has also sparked interest as new methods of powder production, machine technology and build techniques are available [1].
- AM allows intricate, unique and detailed pieces to be produced.
- AM of jewellery provides less production time and enables unique alloys with good thermal and mechanical properties to be used [2].
- A great deal of work has been done since the early 2000s on AM of precious metals however the focus was gold alloys.
- Gold was difficult to work with due to its high thermal conductivity (318 W/mK)) [3] and porosity, hence there was a shift of interest to platinum (Klotz and König, 2023).
- Platinum is easier to work with due to its lower thermal conductivity (71.6 W/mK) [3] and the addition of alloying elements improved its surface quality and reduced porosity [2].

Introduction

- The majority of the world's platinum is supplied by South Africa [4]
- Platinum is used in many industries.
- Depending on preference and demand, platinum can be supplied in a form of powder, which is a crucial feedstock in metal AM.
- For AM excellent quality spherical powder is needed and it must have exceptional flowability [5].



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Introduction

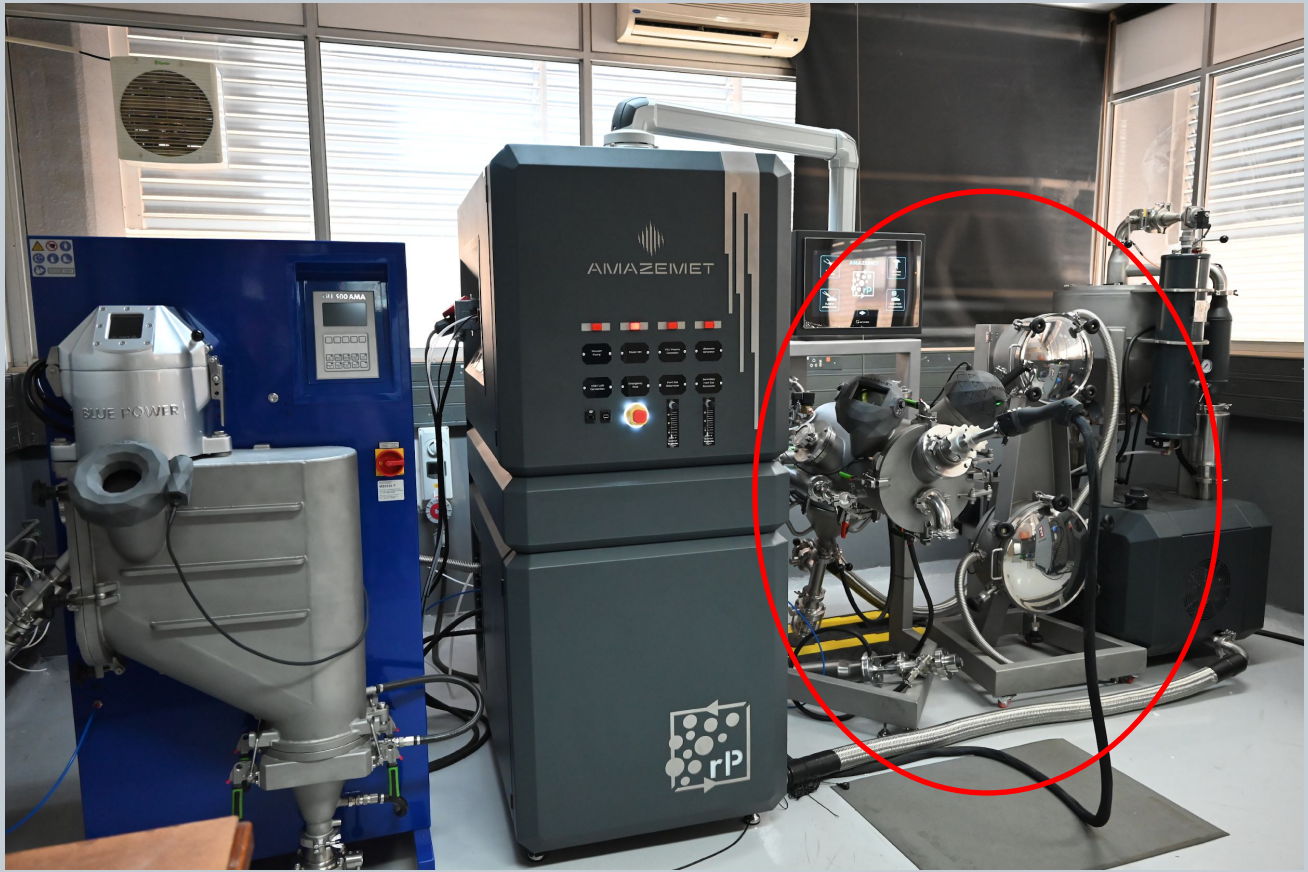
- Current methods for metal powder production include water or gas atomisation.
- The problem with these methods is that they do not always produce very spherical powder and in the case of water atomisation the moisture content is not good enough.
- Also limited due to the enormous atomisation towers needed to control the speed of the particles during the process [5].
- Ultrasonic atomisation has not been studied extensively.
- It uses acoustic waves to break up the molten metal that is in contact with the vibrating surface to give powder [5].
- The ultrasonic atomisation machine used at Mintek can produce spherical powder that has little to no oxidation and moisture. The machine not only produces powder but can also be used to recycle scrap and used powder from AM.

Objectives

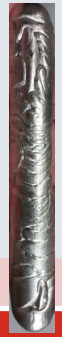
Known jewellery alloy Pt-5Cu (wt%) [1] and previously studied at Mintek,Pt-2.5Ag2.5Au (wt%).

- To make powder and analyse for suitability for use in AM and characterised to determine if particles were alloyed.
- Determine if the particle size distribution is suitable for laser powder bed fusion (LPBF) printing which in addition to spherical particles, requires a particle size distribution of a certain range (30 – 75 microns in general [6]).

Experimental procedure



Experimental procedure



Weighed out 10g of each sample

Melted it into buttons using arc melting

Atomised buttons into powder using 40 kHz

Sieved powder with 75µm sieve

Analysed unmounted powder on SEM and done EDS and analysed mounted powder on SEM for shape and size analysis

XRD powder to confirm elements present

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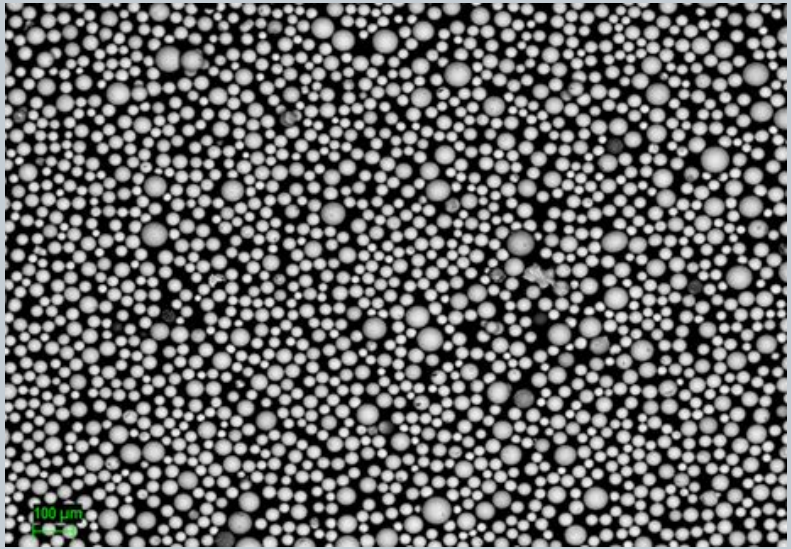
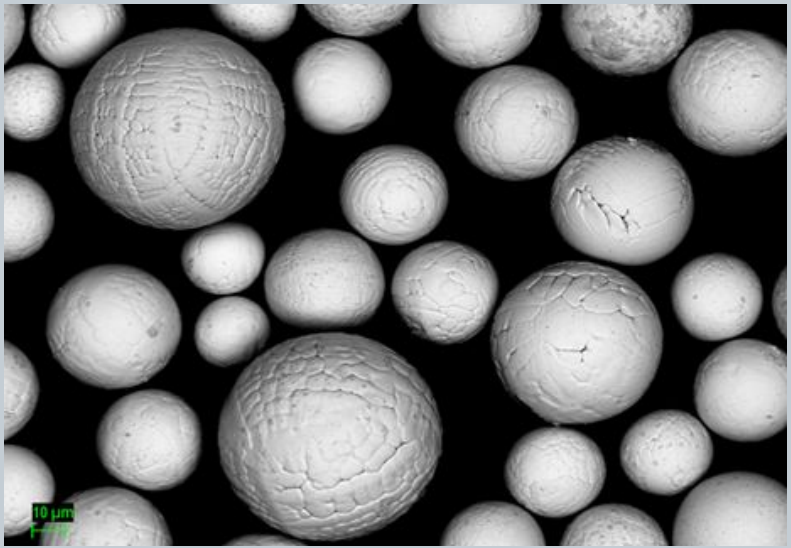
Results and discussion: Pt-5Cu (wt%)

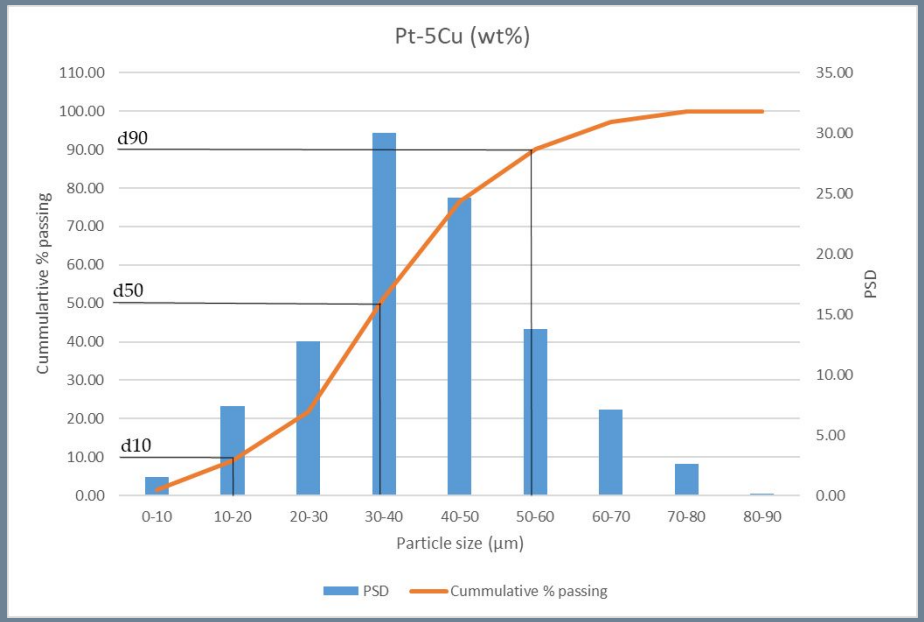


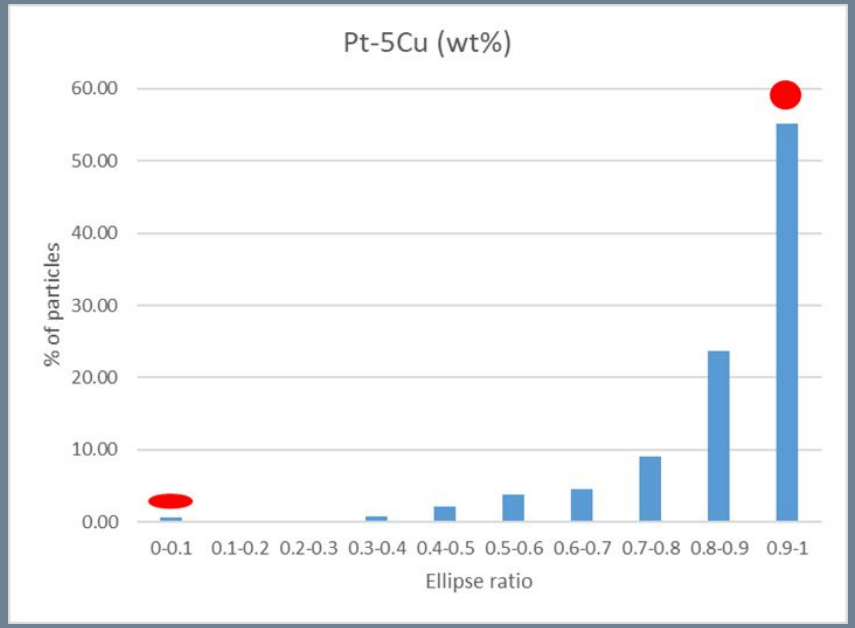


- Spherical with no visible satellite particles
- Overall composition similar to targeted.

	Pt (wt%)	Cu (wt%)
Overall	94.2 ± 1.8	5.8 ± 1.8

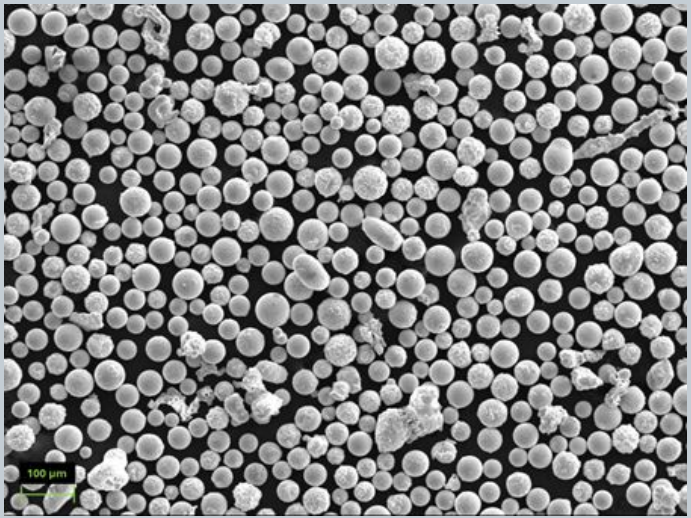
Results and discussion- Pt-5Cu (wt%)

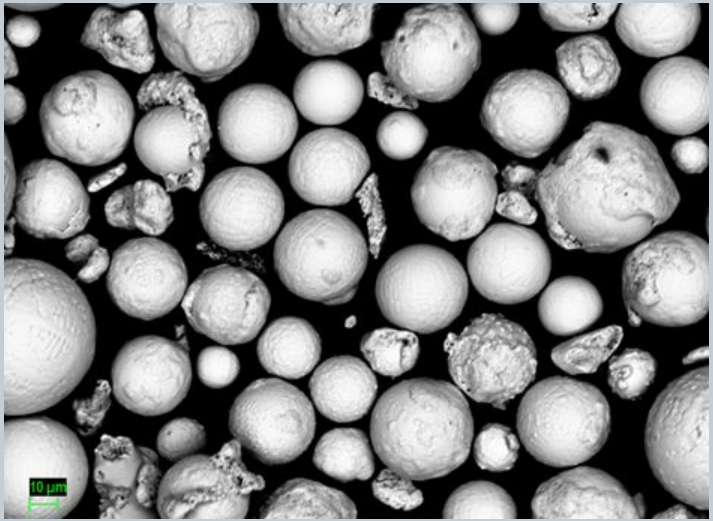




- Majority of particles in 30-60µm
- D90 55µm
- Majority of particles spherical

Results and discussion: Pt-2.5Ag-2.5Au (wt%)



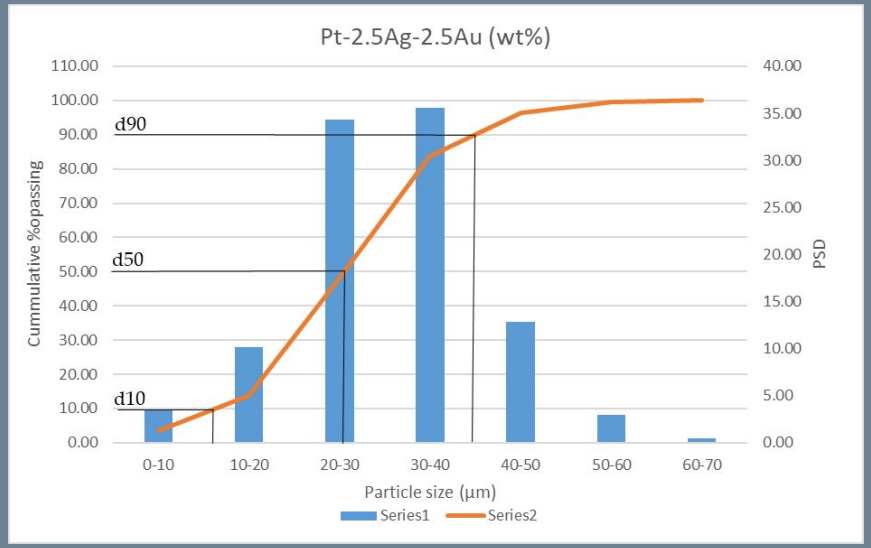


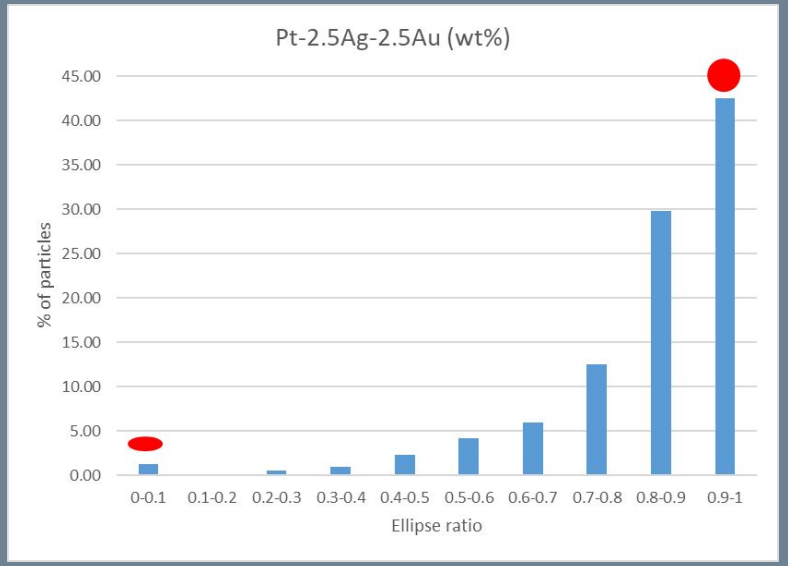
	Pt (wt%)	Ag (wt%)	Au (wt%)
Overall	83.9 ± 4.0	5.1 ± 9.5	11.0 ± 5.4
Irregular particles	45.2 ± 0.1	28.3 ± 0.1	26.5 ± 0.1

Pt	Ag	Au
1767.2°C	1064.28°C	961.78°C

- Alloy composition not successful.
- Irregular particles had far less platinum and more Au and Ag than the targeted alloy
- Coating around the particles is likely soot and irregular shapes.
- The process for alloying will need to be optimised.

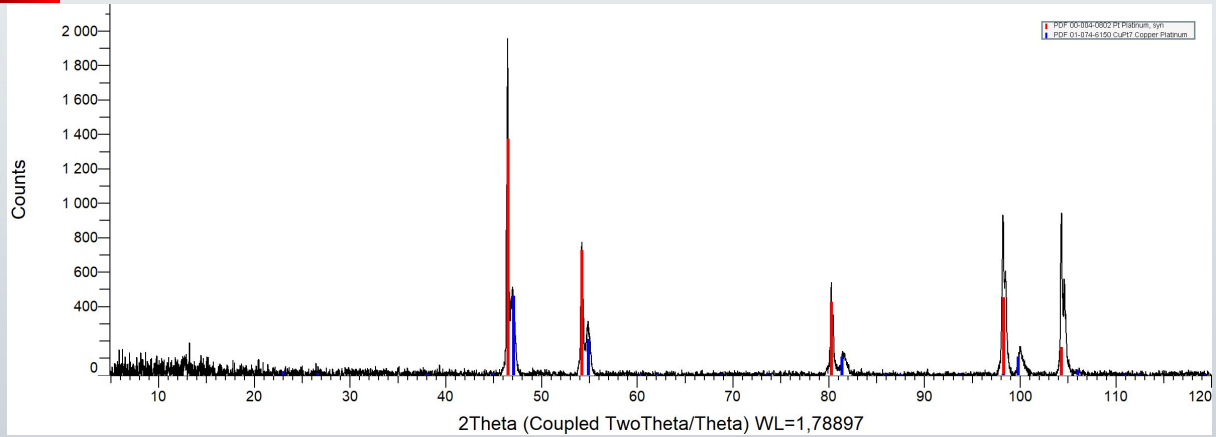
Results and discussion: Pt-2.5Ag-2.5Au (wt%)



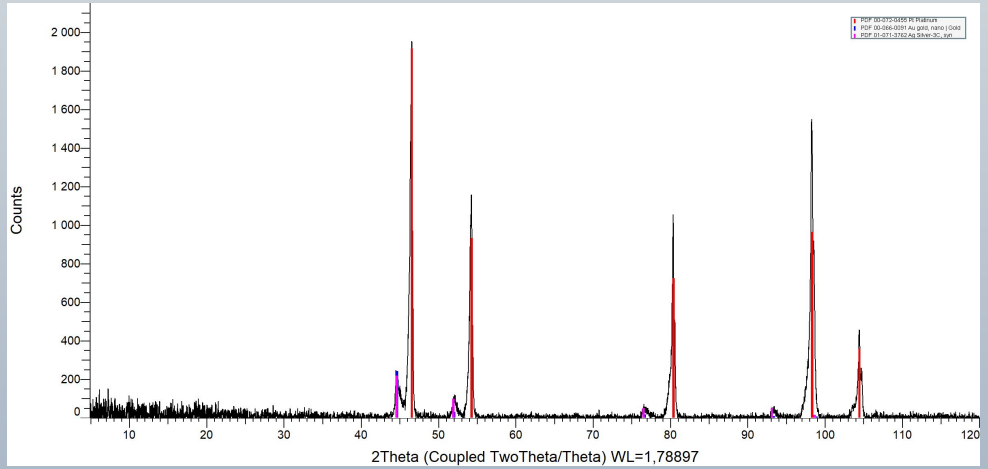


- Majority of particles 20-45µm
- D90 45µm
- Initial spike is non spherical particles

Results and discussion



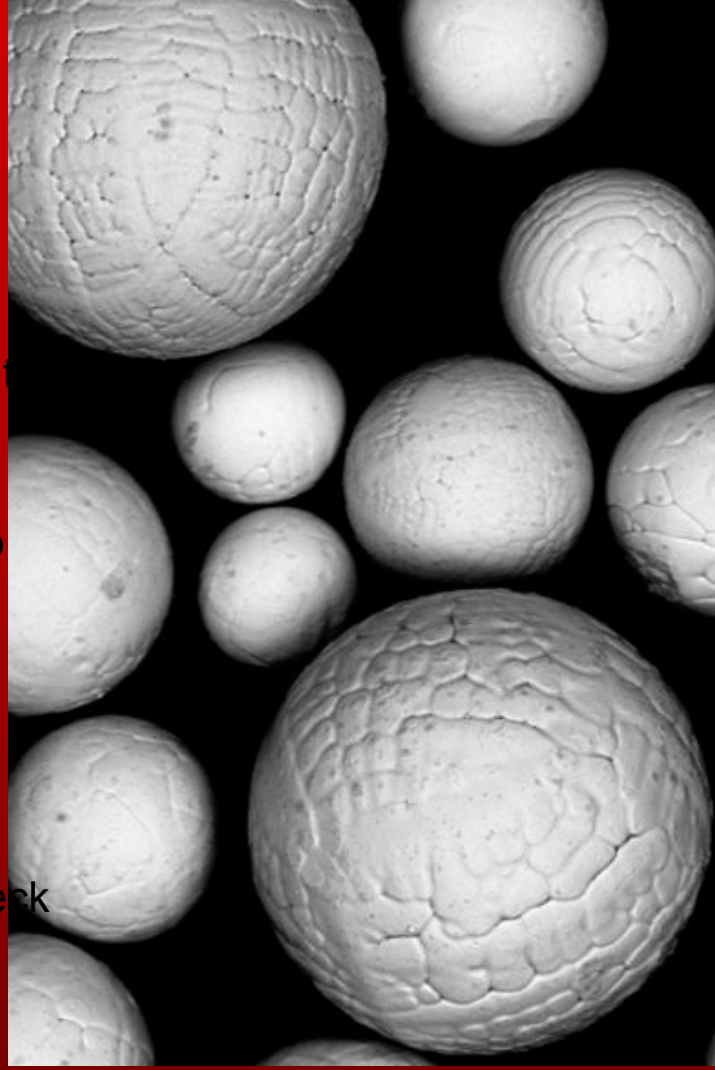
- Platinum
- Platinum copper



- Platinum
- Gold
- Silver

Conclusions

- Each alloy of 10 g was ultrasonically atomised using arc atomisation techniques.
- The method used for Pt-5Cu (wt%) gave alloyed powder wit a similar composition to the targeted alloy composition.
- The Pt-2.5Au-2.5Ag (wt%) alloy particles were mostly spherical and alloyed but the composition was offset due to elevated temperature and small amount of material used.
- While noting that more material in the future shall be considered for better yield
- Can produce powder within the required 30-75 µm range which is suitable for LPBF printing.
- It will also be beneficial to conduct more tests to further check that the powder is suitable such as density tests and flowability tests.



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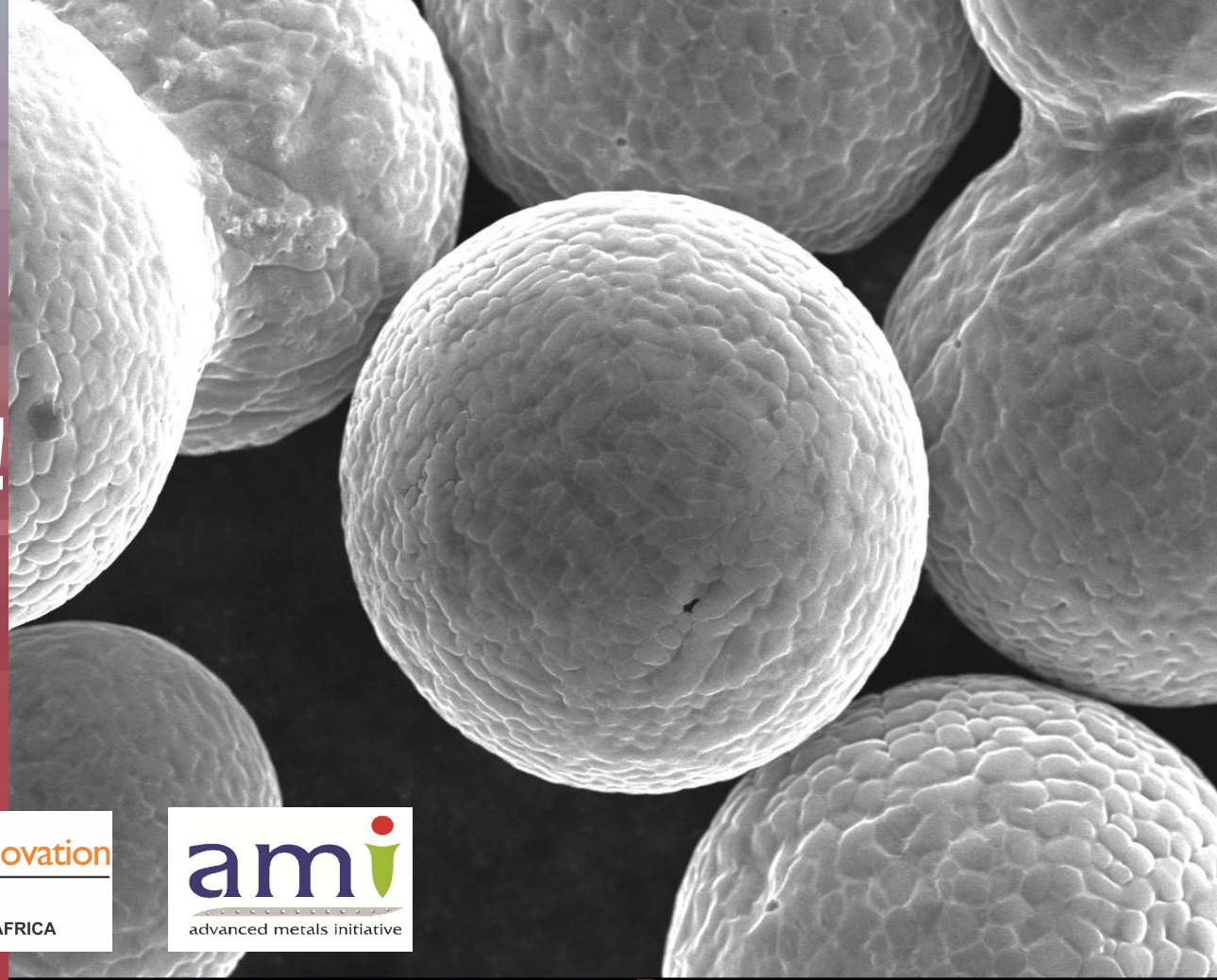
Thank you!



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