

Tap Density Testing for Metal Powders

Why measure the tap density of metal powders for Additive Manufacturing applications?

Determining the tap density of a metal powder gives an indication of the volume occupied by a specific weight of metal powder before and after consolidation by tapping and is a useful measure of powder consistency for comparison and assurance. It also gives an indication of the powder's flow as the interparticulate interactions that determine how a powder consolidates are the same as those that influence powder flow. A change in a powder's ability to flow can affect its behaviour in the Additive Manufacturing process, and once a powder has been characterised and optimal parameters developed for a component, any change in the powder's behaviour can have an impact on the properties of the final built part. Tap density is a valuable process control indicator.

Why use the tap density measurement?

The tap density measurement is a quick, cost-effective, standardised method of determining the change in the volume a mass of powder occupies when it is subjected to tapping. Tap density is influenced by the powder's particle shape and particle size distribution among other properties, and the results can indicate how a powder might consolidate in transit.

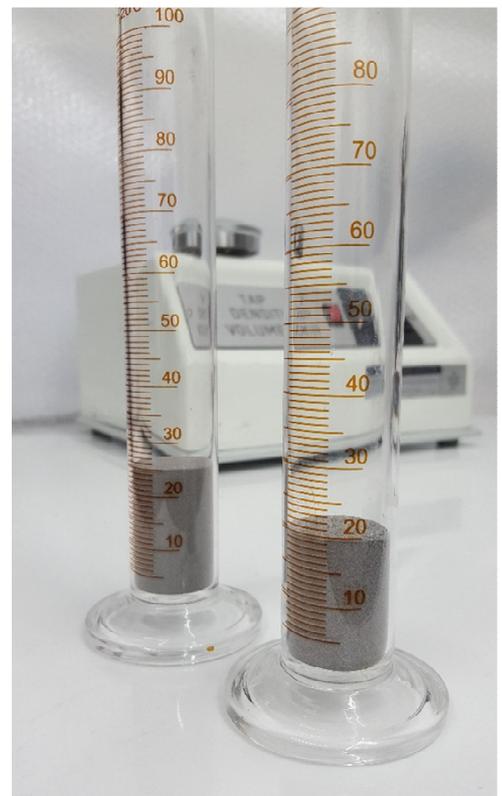
Data extracted from the results can also establish the Hausner ratio - an indication of the flow properties of a powder - through a comparison with the untapped density. A Hausner ratio greater than 1.25 is considered to be an indication of a poor flowing powder.

Tap density methodology

The measurement is conducted to ASTM B527 using specialised equipment.

100g of the sample is introduced into either a 100 cm³ or 25 cm³ graduated volumetric cylinder, depending on the density of the material. The powder sample is poured freely into the glass cylinder ensuring that a level surface forms, and the cylinder is placed into the tapping apparatus. The sample is tapped until the powder settles to a steady state.

The volume of the metal powder is read before and after the test to note any change. The final reading is taken to the nearest 0.5 cm³ when using a 100 cm³ cylinder and to the nearest 0.2 cm³ when using a 25 cm³ cylinder. Tap density is then calculated by: density = mass / volume, reported in g/cm³. It is reported to the nearest 0.1 g/cm³ for powders with apparent densities up to and including 4 g/cm³, and to the nearest 0.2 g/cm³ for powders with apparent densities higher than 4 g/cm³.



The test is repeated three times using fresh powder for each test, and an average result obtained.

Typically, the results generated by tap density testing are used to provide a comparison against the powder's historic performance and previous powder batches to predict repeatability of performance.

All laboratory analysis reports are returned electronically via LPW's secure, encrypted system and treated in the strictest of confidence.

Additional metal powder and Additive Manufacturing testing services

LPW's PowderLab offers a complete suite of tests for enhanced characterisation of powders, fully optimised for specific applications. With our metal 3D printing industry expertise, we can test AM components in validation studies and root cause analysis of failed builds.

Chemical analysis

- Oxygen, nitrogen, and hydrogen analysis by Inert Gas Fusion
- Elemental analysis/Contamination screening (EDX)
- Moisture analysis by Karl Fischer titration

Full Chemical Analysis is available including residual elements and interstitials using various techniques as appropriate, undertaken by ISO17025/Nadcap Approved Lab

Physical analysis

A range of physical tests is available including:

- Apparent/Bulk Density (measurement according to ASTM B212)
- Tap Density (ASTM B527)
- Hall Flow (ASTM B213)
- Carney Flow (ASTM B964)
- Angle of Repose (LPW standardised internal procedure)
- Sieve Analysis (ASTM B214)
- Particle Size Distribution by Laser Size Diffraction (ASTM B822)
- Powder Imaging (SEM)
- Powder Cross-Section/Porosity Imaging (SEM)
- Metallographic sample preparation & examination (SEM)
- Rheometry and Shear Cell Analysis
- True Density by Helium Gas Pycnometry (ASTM B923)
- Quantitative Shape Analysis (Optical & SEM)

All our testing is undertaken to relevant ASTM as standard with ISO available on request, adding consistency and confidence to your process.

For further information on any of our analytical testing services, please contact your local LPW office at www.lpwtechnology.com/contact-us/ or email sales@lpwtechnology.com