

Apparent Density Testing for Metal Powders

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

Determining the apparent density of a metal powder gives an indication of the volume occupied by a specific mass of powder, and is a useful measure of powder consistency for comparison and assurance. 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. Apparent density is therefore a valuable process control indicator.

Why use the apparent density measurement?

The apparent density measurement is a quick, cost-effective, standardised method of characterising the volume occupied by a given mass of metal powder when poured freely into a calibrated container.

Apparent density is influenced by the powder's particle shape, size, and size distribution, among other properties. If a powder sample returns a lower apparent density result than for a previous sample of the same material, it may suggest that particle size and/or spacing has increased. Apparent density is calculated by weighing the mass of the powder required to fill the volume-calibrated apparent density cup.

Apparent density methodology

The measurement is conducted to ASTM B212 using the Hall Flowmeter funnel, and for powders that do not readily flow through this funnel, to ASTM B417 using the Carney Flowmeter funnel.

The empty density cup, which is of known volume, is weighed to the nearest 0.01 g. The powder sample is loaded into the flowmeter funnel and allowed to run freely into the density cup through the discharge orifice. How the powder is poured affects how it packs, so to maintain consistency it is important to introduce it evenly into the cup to ensure that unstable flow does not result in intermittent lumps flattening the contents.



Sufficient powder should be used so that the powder spills evenly over the side of the cup. The powder is then levelled off using a nonmagnetic spatula, the cup is tapped lightly on the side to settle the powder, and any excess powder is removed from its external wall. The filled density cup is then weighed to the nearest 0.01 g, and the weight of the empty cup subtracted to determine the mass of the powder. Apparent density is then calculated by: $\text{density} = \text{mass} / \text{volume}$, reported in g/cm^3 .

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

Typically, the results generated by apparent 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.

LPW PowderFlow kit

To conduct powder flow testing in your own laboratory or production environment, LPW offers PowderFlow. The PowderFlow kit contains a complete suite of powder flow measurement techniques, allowing the measurement of apparent density and angle of repose, and testing of Hall Flow and Carney Flow to relevant ASTM standards.



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