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Application News

No. SCA_300_062

Particle Size Measurements

Metal Powders used for Additive Manufacturing measured with SALD-2300 and MS-23

▪ Introduction

Additive manufacturing (AM), broadly known as 3D printing, is transforming how products are designed, produced, and serviced. AM enables on-demand production, without dedicated equipment or tooling, and unlocks digital design tools, giving breakthrough performance and unparalleled flexibility. Since its inception, significant progress has been made in understanding additive manufacturing processes and the structure and properties of the fabricated metallic components.

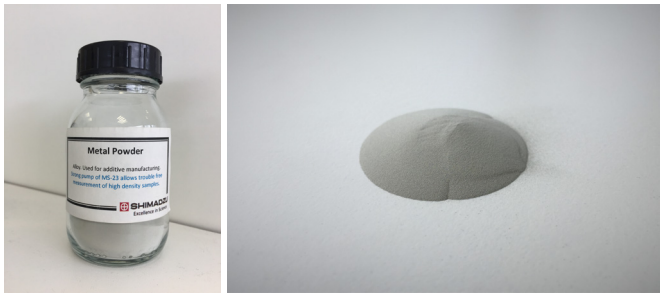


Figure: Metal Powders used for Additive Manufacturing

▪ Why is needed to know the particle size?

With rise of metal powder-based additive manufacturing and its acceptance for critical applications, it has become important to understand the behavior of raw materials used in different AM techniques.
Each of these techniques have their own requirements for material properties in terms of chemistry, purity, density, shape and size affecting the properties of the final part.
In addition to check the raw materials, it makes also sense to check the properties of used powders as they can be recycled, making the entire process more affordable.
However, the limits of reusing powders must be understood so that quality specifications can be maintained.
Particle size is a crucial parameter in a variety of applications fields, such as usage, quality control, research and recycling. Please find below a few examples, where size of the particles is important.

▪ Specific Examples

Size of the powder:

- needs to fit to the machining process (e.g. 15-45 µm for laser powder bed printing, 45-150 µm for laser deposit welding)
- affects the microstructure and mechanical properties of the finished product (during production process, the laser energy is directly absorbed by the metal powder particles. Finer particles provide a larger surface area and may absorb more laser energy. This increases the particle temperature and the sintering kinetics. The thermal history of the specimens defines the resulting microstructure and mechanical properties of the finished product.)
- respectively the amount of agglomerates defines the reusability of the powder. (in the productions process, even powder particles of the loose powder which are not in the finished product may fuse together and form conglomerates. If this powder is reused, these agglomerates affect the flowability and packing density. In the worst case, this can make the powders unusable.)

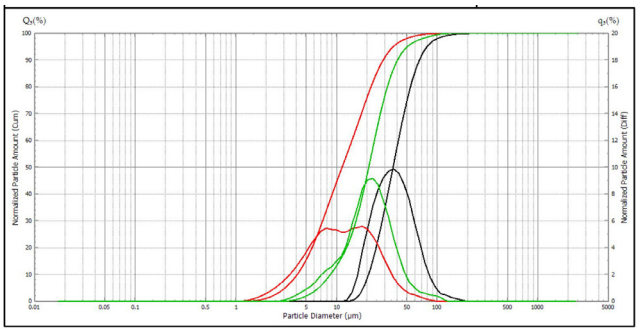
Laser Diffraction:

A suitable method to determine the particle size of metal powders is laser diffraction. In case of this method the powder is suspended with a solvent (in the simplest case water). The suspension is pumped through a flow cell. The cell is irradiated by laser light. The light is diffracted and scattered by the particles. Light detectors arranged around the measuring cell detect a light pattern created by the particles. Depending on the size of the particles, the pattern of the light distribution changes. Thus, it is possible to distinguish between particles of different sizes.

The decisive point when using this method is that the particles are also located in the flow cell. As trivial as this task sounds, as challenging it can be. The metal powders can sometimes have a very high density. If the laser diffraction devices is equipped with a pump that is too weak, it can happen, that the particles remain in the tubes or remain on the bottom of the storage vessels. If they are not transported through the measuring cell, they are not measured. It can also happen that only the lighter (smaller) particles are transported. In both cases, no reliable statement can be made about the size distribution of the powder.

Measurements:

The SALD-2300 Laser Diffractor with MS-23 from Shimadzu is a system capable of measuring even the most difficult particle samples. Among other things, it is able to reliably measure the size of stainless steel balls with a size over 2 mm in suspension. It is therefore perfectly suited to reliably measure powders used for additive production, which typically have a size of less than 200 µm.



sample name	RI	D1	D10	D50	D90	D99	Median D	Modal D	Mean V	Std Dev
metal_sample_1	Fraunhofer	14,5	20,4	36,1	66,6	118,2	36,1	38,8	36,7	0,20
metal_sample_2	Fraunhofer	1,9	4,0	11,2	28,9	59,2	11,2	19,0	11,0	0,33
metal_sample_3	Fraunhofer	4,2	8,6	20,6	40,5	85,7	20,6	24,1	19,8	0,26

Figure 2: different metal powders measured with our SALD-2300 with MS-23

▪ Conclusion

Laser diffraction instruments can be used in various functions to monitor particle size: In the R&D sector, to evaluate the influence of particle size on material properties of additive manufactured components, in the monitoring of existing systems, incoming goods inspection, as well as the recycling of the used powders.

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