APPLICATION NOTE

Frontier of 3D Printers and Evaluation of the Physical Properties of Powder Involved

Overview

Three-dimensional (3D) printers have become familiar for consumers in general, enabling utilization in production services at low cost starting at a few thousand Yen. The market size for 3D printers is estimated to grow to about 2 trillion JPY in 2030. 3D printers can be classified into several categories according to the processing methods involved. Various materials, including not only power but also fluid, sheets, etc., are used for this type of printer. The 3D printer technology which utilizes powder is now attracting close attention and the Technology Research Association for Future Additive Manufacturing (TRAFAM) has been set up which concentrates on powder utilization technologies. Here, the features required of the powder used for 3D printers and the methods for evaluating the properties of this type of powder are presented, citing actual examples of powder measurement.

Powder used for 3D printers

Thermoplastic resin powder, metallic powder and ceramics (fire-proof materials, artificial powder) are primarily used for 3D printers. Metallic powder, e.g. is required to have the following features when used for 3D printers.

- Can melt and solidify in a short time
- Powder has high fluidity
- Powder allows high-density filling

To meet these requirements, it is desirable that the powder assumes a spherical form with relatively constant particle size (narrow range of particle size distribution). At present, the metallic powder used for 3D printers has a mean particle size of about several tens μm. Because the national project has set the final target precision of the 3D-printed products at ±20 μm or ≤50 μm (depending on the type of beam used), it is predicted that in future the size of powder used for 3D printers will further decrease within the fluidity-assured range.

Apparatus

Particle Size Distribution Measurement System MT3300EX II

Principle of measurement:
Laser diffraction / light scattering
Range of measurement:
0.02-2000 μm

Particle Shape Evaluation/Particle Size Distribution Measurement System S3500 SI

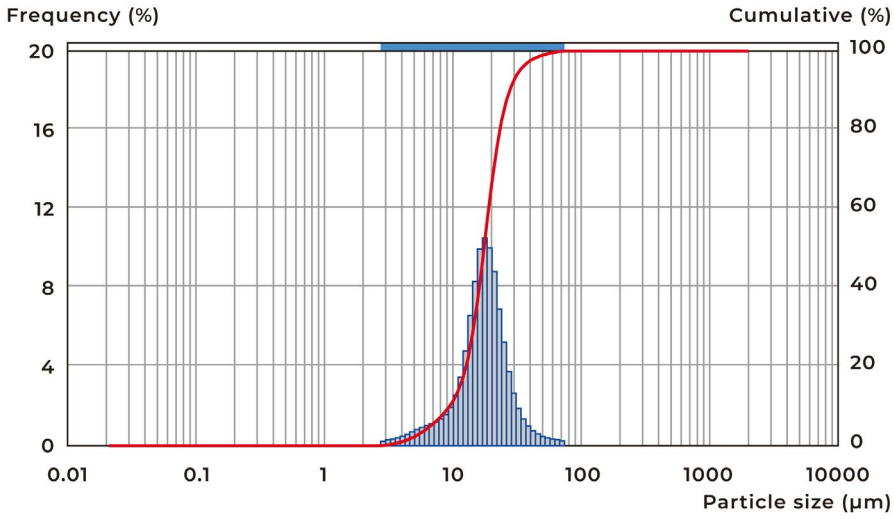
Principle of measurement:
Image analysis
Range of measurement:
5-1500 μm

Example of MT3300EX II & S3500 SI combination

Results

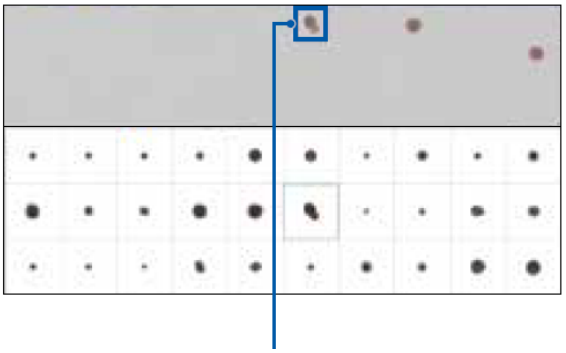
Sample; Metallic powder for 3D printers

(1) “Particle size distribution evaluation” with laser diffraction / light scattering MT3300EX II



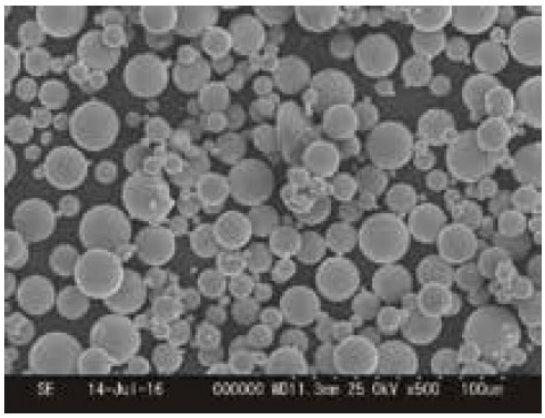
Mean particle size (volume-based): MV = 18.53 [µm]
Distribution width (cumulative 5-95%): W = 26.24 [µm]
Measuring time: 10 [sec]

(2) “Shape analysis” with image analysis S3500 SI



Maximum Feret diameter: 37.43 [µm]
Minimum Feret diameter: 22.06 [µm]
Circularity: 0.769

SEM image (reference)



Results, Discussion and Conclusions

It has been confirmed that if the laser/diffraction/light scatttering unit MT3300EXII is combined with the image analysis unit S3500 SI, a rapid and highly precise evaluation of the “sharp particle size distribution” and “spherical particle” which are features required of powder in 3D printers is possible. With the MT3300EXII, the mean particle size and distribution range can be evaluated in very short time (10 seconds). With the S3500 SI, the presence of some particles of atypical shapes (having a low aspect ratio) among a majority of highly circular particles was detected. These particles with atypical shapes are estimated to have been formed during powder production or to have arisen from the aggregation of particles during handling (e.g., sorting).

Remarks

What is a 3D printer?

It is used for directly manufacturing models and other products through piling one layer of material on another in a serial manner on the basis of 3-dimensional drawing data. Strictly saying, it employs the technology called “additive manufacturing” which has the following characteristics.

Characteristics of 3D printers

- Advantageous in high-mix small-volume production
- Enabling rapid production (on a trial basis, etc.)
- Enabling production of products with complex shapes not possible with conventional processing methods

History of 3D printers

Invented in 1980 by Mr. Hideo Kodama from the Nagoya Municipal Industrial Research Institute. The first product utilizing a 3D printer was marketed by Mr. Charles W. Hull (the founder of 3D Systems). Twenty years later, i.e., after the expiry of the patent period for relevant technologies, low-priced 3D printers began to be marketed. In Japan, the media began to report on 3D printers in 2012 leading to their current boom.

For further information please contact us at:

www.microtrac.com