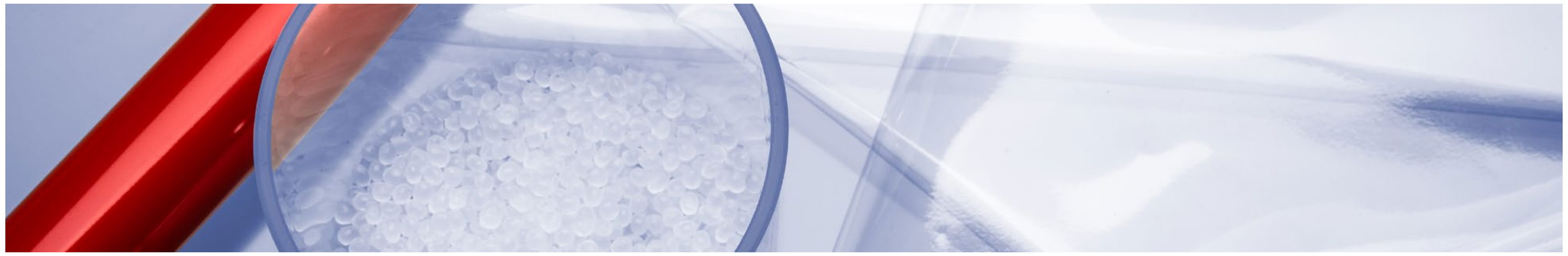
Anton Paar

Additive Manufacturing

Solutions for Additive Manufacturing

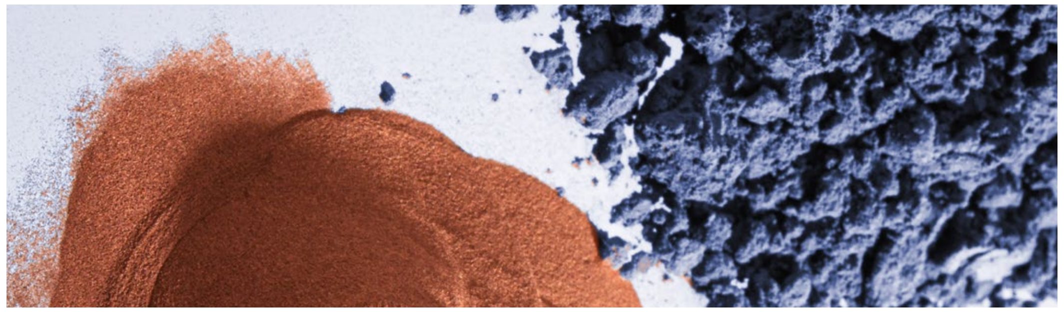
Analytical methods for **additive manufacturing**

THERMOPLASTIC POLYMER GRANULATE FOR 3D PRINTING



CHALLENGE	**The granulate agglomerates, and blocks the supply line of the printer.**	**The granulate shows different melting properties from batch to batch.**	**The melted polymer is too viscous/fluid, which has a negative influence on the final component – its surface is uneven.**	**Non-optimal material properties can affect the liquid and solid behavior, and also the thermal properties of polymers, resulting in unstable or deformed products.**
SOLUTION	Measure the surface charge of your granulate with a SurPASS 3 zeta potential analyzer to optimize the inline flow.	Establish quality control of incoming raw materials: Measure the skeletal density by gas pycnometry with the Ultrapyc series and determine the porosity with instruments of the Nova series, Quadrasorb, autosorb iQ series, and PoreMaster.	Find out about the viscous and elastic properties of your thermoplastic polymer as influenced by temperature and processing conditions with an MCR Evolution rheometer.	Optimize the polymer material at the atomic level by measuring the polymeric structure and degree of crystallinity using X-ray diffraction with XRDynamic 500.
YOUR BENEFITS	At just the touch of a button, you can investigate your sample – non-destructive and suitable for a variety of sample geometries. According to the results, you can then take measures to improve the material properties and avoid clogging of the lines in the future.	Simple and fast analysis of density and porosity provides ideal parameters for quality control and materials' optimization with respect to process parameters.	With the results you can precisely predict the rheological behaviour of the polymer during processing and optimize processing parameters and material selection for additive manufacturing.	Rapid, automated XRD measurements of polymer materials allow fine-tuning of the material properties to ensure the quality of your printed products.

METAL POWDER FOR SINTERING



CHALLENGE	**The final product is too brittle and breaks down very quickly if loaded at temperatures below a certain value during storage and use.**	**The flowability of the powder is not good enough and the product is inhomogeneous.**	**The sintered product is too fragile or porous.**	**The metal powder flow through the sinter nozzle is very inconsistent.**
SOLUTION	Determine the dynamic mechanical properties as a function of temperature and transition temperatures as influenced by the composition of the polymer with an MCR 702e MultiDrive.	Use a PSA particle size analyzer to define the distribution and the mean size of the particles. The size distribution is an important parameter which influences the performance of the raw material and therefore the quality of the final product.	Use a PSA particle size analyzer to measure the particle size distribution – and therefore the packing density – of your raw powder or suspensions.	Determine rheological properties such as powder flow with an MCR powder rheometer.
YOUR BENEFITS	Optimize the material composition to adapt the suitable material properties to the temperature range during storage and use.	The size distribution gives insights into the homogeneity of the surface of the powder. It depends on the final product which size distribution is needed – with PSA you can ensure that your powder always has the grade of homogeneity you need.	The performance and homogeneity of a product depend on the packing density of the particles: The broader the size distribution, the better the packing of the particles and the more stable the sintered product.	Knowledge about the rheological properties of a powder enables you to find the optimal flow speed and thus select the ideal nozzle design. This has a positive influence on the final component's quality.

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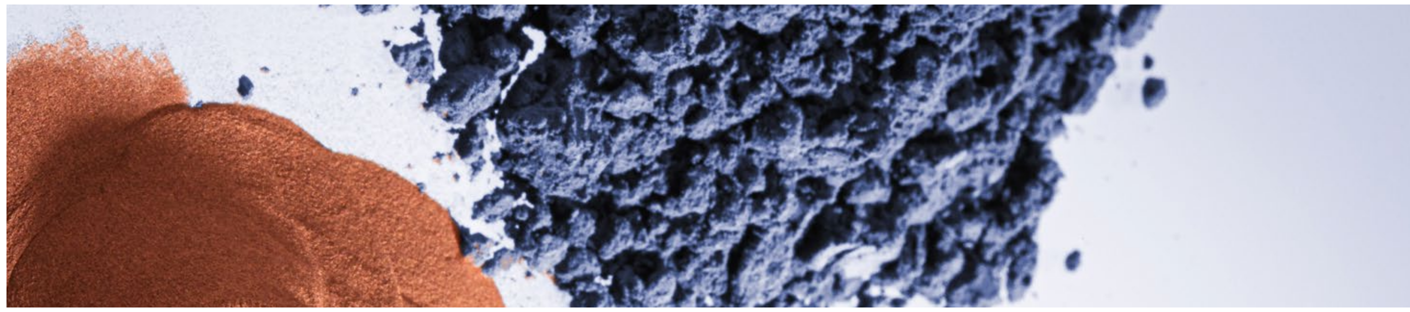
METAL POWDER FOR SINTERING



CHALLENGE		
You want to reuse the excess metal powder from past productions and want to know if it is still usable.	**Low quality of the metal powder can lead to problems during sintering, or fragile final products.**	**The powder bed density is too variable.**
SOLUTION		
Measure the cohesion strength with an MCR powder rheometer to find out the flowability of the recycled powder. Additionally you can characterize the rheological behavior of the metal alloy melt of the powder using a high-temperature viscometer and rheometer.	Optimize raw materials during development and maintain strict quality control. XRDynamic 500 can be used to determine the phase purity of metal powders to detect even minor impurities. The particle/crystallite size can also be characterized to ensure optimal powder properties.	Use an Autotap density analyzer to determine what the uncompressed powder density really is.
YOUR BENEFITS		
Knowing the flowability, you can calculate how much new powder you have to add to make the powder usable for high-quality end products. And by measuring its viscosity you can react to changed melting behavior and altered viscosity caused by oxidation or contamination in the recycled powder.	In one fast XRD measurement, you can analyze the phase purity and crystallite size of metal powders used in the sintering process.	Screen both fresh raw material and recycled powder to anticipate issues and make process adjustments as necessary.

FINISHED PRINTED COMPONENTS

CHALLENGE			
You want to find out how resistant the final printed component is.	**You want to know how a component behaves when in contact with other surfaces – without conducting extensive tests.**	**Some printing processes utilize rapid heating and cooling cycles which can lead to residual stresses in the printed materials affecting the mechanical properties and leading to fatigue.**	**Determine if full densification has occurred, or the desired porosity meets the design parameters.**
SOLUTION			
Measure the critical load, adhesion, scratch resistance, roughness, and viscoelastic behavior with a NST³ nano scratch tester or a NHT³ nanoindenter.	Find out about the friction and wear of your component with a TRB³ pin-on-disk tribometer.	Determine the residual stresses present in printed components via XRD measurements with XRDynamic 500.	Measure skeletal density with an Ultrapyc gas pycnometer and pore size distribution with a PoreMaster mercury intrusion porosimeter.
YOUR BENEFITS			
Compliance with ISO 20502 and ASTM C 1624 ensures that your product always satisfies your customers.	The pin-on-disk method is a fast and accurate method that will give you results in a very short time – ideal for efficient quality control of final products.	Residual stress analysis of printed components via XRD allows optimization of the entire additive manufacturing process – from raw materials through to the finished product.	Track the influence of raw material quality and process variations to optimize those that minimize or eliminate closed porosity.

Anton Paar has the **know-how** for

Rheology

With the MCR Evolution rheometers, the full array of shear rheology, powder rheology and DMA on polymers and metals can be used to characterize materials and processes necessary for additive manufacturing. The versatile and powerful MCR rheometer offers high reproducibility, fully automated measurement modes, and multiple measurement modes for quality control as well as scientific purposes.

PARAMETERS:

Powder flow | Cohesion strength | Flowability | Compressibility | Bulk density | Permeability | Deaeration time | Pressure drop | Wall friction angle | Storage, loss, and complex modulus | Glass transition and melting temperature | Viscosity

Surface area and pore size analysis

Physisorption and mercury intrusion measurements provide quantitative information about powders and porous materials' external and internal morphology. Data from the Nova series, the Autosorb iQ series, the QuadraSorb, and the PoreMaster allow for optimization of process design and control.

PARAMETERS:

Surface area | Pore size | Pore volume

Solid density analysis

The Ultrapyc's ultra-simple and ultra-precise operation rapidly delivers material property values that reflect alloy composition, blend composition and crystallinity. Autotap provides basic powder packing characteristics for volume filling calculations.

PARAMETERS:

Parameters: True density | Skeletal density | Porosity | Tapped density | Carr's Index | Hausner ratio

Surface characterization

Anton Paar offers measuring solutions for indentation testing, scratch testing, tribological tests, and surface charge analysis. This variety allows the measurement of a wide range of properties. All instruments deliver highly accurate results and offer operation and software to support instrument operators.

PARAMETERS:

Hardness | Elastic modulus | Deformation | Adhesion | Scratch resistance | Friction | Wear | Surface charge

Anton Paar Certified Service

"We're confident in the high quality of our instruments. That's why we provide **a full warranty for three years**."

All new instruments* include repair for three years.
You avoid unforeseen costs and can always rely on your instrument.
Alongside the warranty, we offer a wide range of additional services and maintenance options.

*Due to the technology they use, some instruments require maintenance according to a maintenance schedule. Complying with the maintenance schedule is a prerequisite for the three-year warranty.

Particle characterization

The better you know your particles, the better you can predict your material's behavior during manufacturing. The Litesizer and PSA series of particle size analyzers, give you access to a great variety of results. All in all, Anton Paar offers the broadest particle characterization portfolio available from one single provider worldwide.

PARAMETERS:

Particle size distribution (measured dry or wet) | Pore size | Pore distribution | Zeta potential | Molecular mass | And more

X-ray diffraction (XRD)

XRD is a powerful technique that can be used during development or in quality control of the polymers or metal powders used in additive manufacturing. It can also be used to test the quality of the final printed products. With XRDynamic 500, Anton Paar offers an automated multipurpose powder X-ray diffractometer that delivers outstanding data quality, maximum measurement efficiency, and covers all of the XRD measurement requirements related to additive manufacturing.

PARAMETERS:

Phase composition (qualitative and quantitative) | Crystal structure | Particle/Crystallite size | Texture (crystallite orientation) | Residual stress/strain

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