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Additive Manufacturing: Analysis Along the Entire Value Chain

Additive Manufacturing, also referred to as 3D printing, has become an established manufacturing process that enables the creation of a variety of products with freedom in design and choice of material (polymers, metals, ceramics).

After enabling the production of customized consumer products, Additive Manufacturing has entered the medical, aerospace, and automotive industries. The high demands on product quality in these sectors has substantiated the need for advanced materials characterization, often according to standards.

Analyzing the Value Chain

To ensure a reproducible production process, and optimal product performance and lifetime, analysis is required along the entire value chain: From concept and research to prototype design and process verification to post-market surveillance.

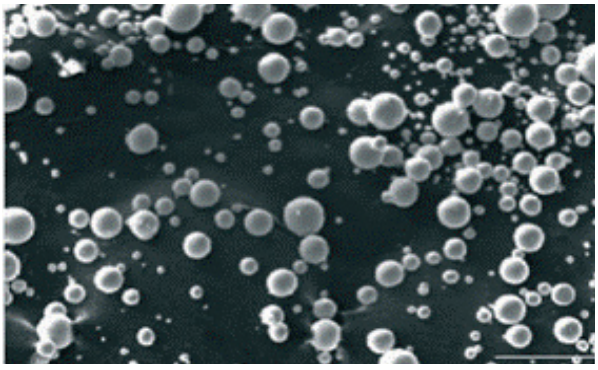
- **Raw materials (feedstock)** – The properties of the raw material have a strong influence on the quality of the final product. Characterizing the chemical composition, purity, particle size, morphology, batch-to-batch variation, homogeneity, etc. will contribute to the production of reproducible, high-quality parts and products.
- **Process optimization** – Correlating process parameters and their variance to product properties is crucial for process optimization. By characterizing processed parts and products, the defect density, porosity and roughness can be minimized, and the compositional homogeneity and mechanical properties can be optimized.
- **Finished parts/products** – Assessing the quality and reliability of produced parts and products.
- **Aging** – Accelerated lifetime studies to gain insight into degradation mechanisms.
- **Failure analysis** - What if the final part breaks or does not reach the required specifications? What is the root cause? How can we learn from it, anticipating for the future?

Eurofins Materials Science & Engineering

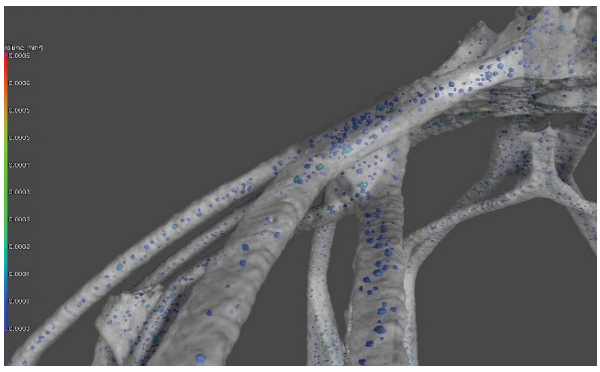
Eurofins Materials Science and Engineering is a network of analytical facilities across Europe. It offers unmatched capability and analytical expertise, a unique range of in-house techniques and instruments, reliability testing and flexible problem solving.

Apart from performing material and reliability studies, Eurofins Materials Science and Engineering offers:

- **Analytical Methodology** – Our experts can help you create a design of experiments (DoE) to accelerate product innovation.
- **Materials Consultancy** – With over 40 years of experience, our material experts bring valuable insights regarding choice of material and root-cause studies.
- **Reliability of Materials and Products** – Turn to our experts for testing and predicting behavior during the lifecycle of a product and its interaction with its environment to resolve reliability issues, ensure quality control, and identify and prevent early degradation.



Particle size distribution



Porosity analysis on a 3D printed part

Standards & Methods

Requirements for quality control have stressed the need for test standards. Many of the techniques and analyses listed in this table are operated according to standards (ISO, ASTM).

Global Support

Eurofins EAG Laboratories has 600+ highly-educated employees and 20+ facilities around the world. The Eurofins company is the global leader in Materials and Engineering Sciences. Learn more at EurofinsEAG.com

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	Application	Technique
Raw material (feedstock) qualification	Particle size distribution	Laser diffraction, Sieve analysis
	Apparent density	Archimedes, Helium pycnometer
	Tap density	Tapped density
	Flowability	Carney Funnel, Hall Flowmeter
	Composition, trace elements and impurities	ICP-OES, ICP-MS, GD-MS, GD-OES, XRF, FT-IR, IGA (C-S-N-O-H)
	Porosity	SEM, BET
	Specific surface area	BET
	Humidity	TGA
	Phase identification	XRD
	Morphology	SEM, optical microscopy
R&D Process optimization	Thermal properties	DSC, TGA
	Mechanical properties	Tensile, compression, bend, impact testing, hardness
	Surface roughness	Profilometry
	Porosity	SEM, BET, X-ray CT
	Density	Archimedes, Helium pycnometer
	Surface composition	XPS, TOF-SIMS
	Surface layer thickness	FIB, TEM
	Microscopic and macroscopic structure	FIB, SEM, TEM, optical microscopy
	Internal defects and hidden structures	X-ray CT
Qualification of parts and products	Mechanical properties at ambient or different temperatures (cryo and high temperatures)	Tensile, compression, bend, impact testing, hardness
	Composition, trace elements and impurities	ICP-OES, ICP-MS, GD-MS, GD-OES, XRF, FT-IR, IGA (C-S-N-O-H)
	Stains and discolorations	XPS, SEM
	Defects and hidden structure (inclusions, cracks, porosity, phases, powder residues)	X-ray CT (in general non-destructive testing)
	Dimensions	3D measurements
	Phase identification	XRD
	Grain orientation	SEM-EBSD, XRD
	Accelerated lifetime testing	Salt Spray testing, high pressure, high/low temperature (cycling/shock), HAST, Solar/UV simulation, IP testing, HALT, MEOST, chemical compatibility
	Failure analysis (fatigue, fracture, stress corrosion cracking, etc.)	Metallography, fractography, SEM, EPMA

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