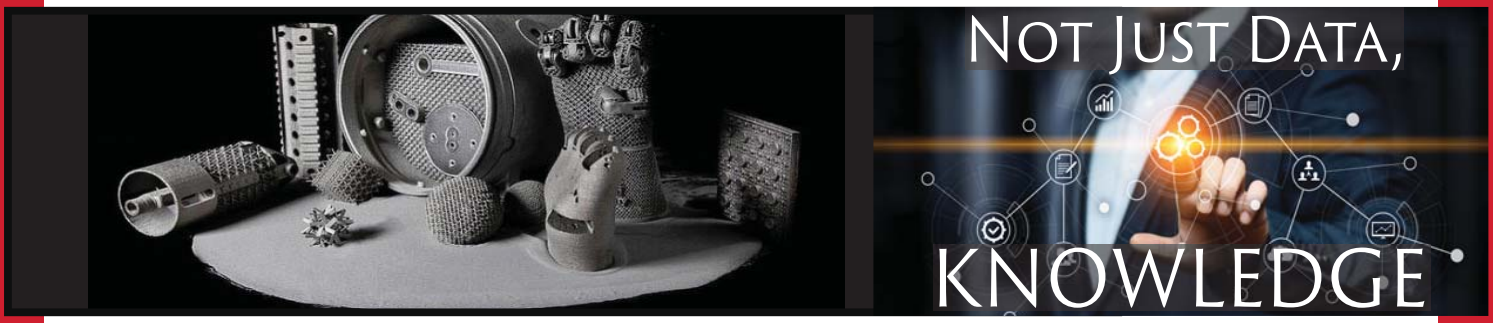
IMR Test Labs Knowledge Sheet

ADDITIVE MANUFACTURING TESTING & ANALYSIS



POWDER - PROTOTYPES - PRODUCTS

Additive Manufacturing (AM), also known as 3D Printing, is changing the way products are designed, prototyped, produced and brought to market in many high-tech fields such as Aerospace, Medical Device, Transportation and Power Generation.

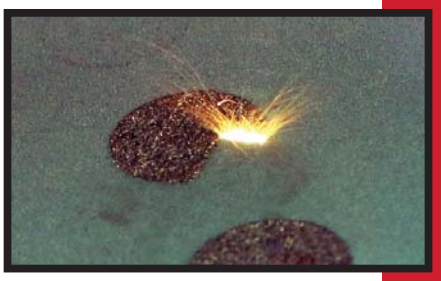
With the growth of AM, the need for reliable analytical testing is more important than ever. IMR Test Labs offers a wide variety of testing solutions to ensure the integrity of the raw materials and the finished products and componenents they produce.

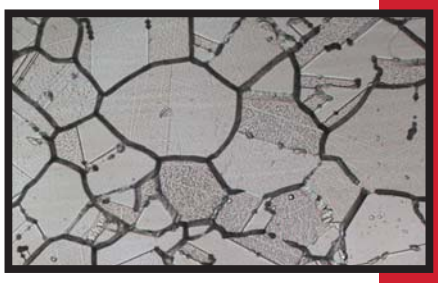
For example, IMR provides comprehensive powder analysis to fully characterize the starting powder via test methods such as:

- Chemical Analysis (ICP-AES, ICP-MS)
- Percent Crystallinity Testing
- Particle Size Testing (Microtrac)
- Morphology Analysis (XRD, SEM and Optical)

Additionally. we offer density testing on samples to determine how compact the sample has become after bonding, and compression testing to dtermine how much force a sample can handle. A full list of analytical services offered by IMR for Additive Manufacturing is listed on the back page of this Knowledge Sheet.

Quality is a priority at IMR Test Labs and we've instituted strict quality control systems to ensure testing is completed with the utmost integrity. See our website for a full list of accreditations.





NOT JUST DATA, *KNOWLEDGE*

Our reports and analyses are clear, concise and complete.
We are prepared to discuss the results at any time. If you require expedited testing, we're willing and able to deliver high-quality test reports on a timeline.

CURTISS-WRIGHT
IMR TEST LABS

www.imrtest.com

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ANALYTICAL SERVICES FOR ADDITIVE MANUFACTURING TESTING

METALLURGICAL ANALYSIS

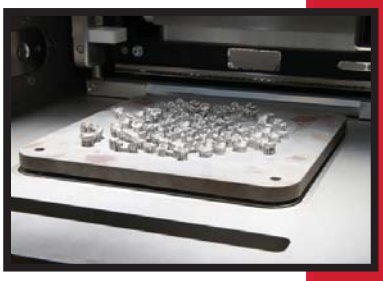
Alpha Case
Aggressive Machining Evaluations
Braze Analysis
Case Depth
Certified Weld Inspections
Coatings Analysis
Decarburization
Failure Analysis
Fractography/Fracture Mechanics
Grain Size
Image Analysis
Inclusion Rating
Intergranular Attack
Intergranular Oxidation
Macroetch/Microetch
Metallography/Materialography
Microhardness (Knoop, Vickers, MacroVickers)
Microstructure
Orientation in Microstructure
Particle Analysis (Distribution, ID, Size)

MECHANICAL TESTING

Bend Testing (3 Point, 4 Point)
Bond Strength Testing
Charpy Impact Testing (-320°F to 450°F)
Coefficient of Thermal Expansion by TMA
Composite Testing (FRC, CMC)
Creep & Stress Rupture
Fatigue Testing (Axial, Low Cycle, High Cycle, Rotating Beam, Coating Shear)
Flexural Properties (Modulus, Strength, Stress-Strain Response)
Fracture Mechanics
Hardness (Rockwell, Brinell)
Heat Aging
Indentation Toughness
Impact Testing (Charpy, IZOD)
Lap Shear Testing
Open Hole Tension/Compression
Shear Properties
Slow Strain Rate
Taber Abrasion/Wear Resistance
Tensile Testing - Metals (to 2000°F)
Torsional/Axial Fatigue (200 lb)

CHEMICAL ANALYSIS

Alloy Chemistry/Verification
Ash Content
C, H, O, N, S
Chemical Resistance
Cleanliness Testing
Coating Weight
Contaminant/Corrodent Analysis
Density
DSC Analysis (Melting Point, Glass Transition, % Crystallinity, Degree of Cure, Purity)
Filler Content Analysis
FTIR Analysis
GC/MS Analysis
Halogen Analysis (IC)
Heavy Metal Impurities
Hexavalent Chromium
ICP-AES Analysis
ICP-MS Trace Element Analysis
Ion Chromatography (IC)
Material Certification
Mercury Analysis
Metallic Material Verification/ID
OES Analysis
Particle Size Analysis
Percent Crystallinity
Phase Identification
Positive Material ID (On-site PMI available)
Powder Diffraction
Precious Metal Assay
RoHS Testing
SEM/EDX
Sieve Analysis
Trace Element Analysis
Unknown Material ID
X-Ray Diffraction (XRD)
XRF Chemistry



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CERTIFICATE #1140.10

Accredited Nadcap™
Materials Testing Lab
Non-Metallic Materials Testing

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IMR TEST LABS

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