

SAE INTERNATIONAL

# ADDITIVE MANUFACTURING STANDARDS DEVELOPMENT



**SYNONYMOUS WITH MOBILITY ENGINEERING, SAE DEVELOPS MORE VEHICLE TECHNICAL STANDARDS THAN ANY OTHER ORGANIZATION, OFFERS THE LARGEST COLLECTION OF VEHICLE ENGINEERING CONTENT, AND BOASTS THE LARGEST NETWORK OF GLOBAL ENGINEERS ON EARTH.**



“SAE has always been a great resource for specifications that we can use to design and qualify our parts. We are happy to see that SAE is taking the lead in additive manufacturing by developing specifications with associated design values.”

**Paul Jonas**, Chair of Polymer AM Subcommittee and Director - Technology Development & Programs, National Institute for Aviation Research, Wichita State University

SAE International is the Standards Development Organization uniquely dedicated to solving the toughest technical challenges of the aerospace and ground vehicle sectors through industry-driven, consensus-based standards development.

Additive manufacturing (AM), sometimes referred to as three dimensional (3D) printing, is emerging as a transformational technology in the aerospace and defense industry. Industry standards are necessary to establish a material qualification system to assist with addressing global aerospace regulatory requirements.

Regulatory agencies increasingly rely on industry standards to support regulations and acceptable means of compliance. In October 2015, the Federal Aviation Administration (FAA) issued a tasking request to SAE to “develop Aerospace Materials Specifications, process standards, Aerospace Recommended Practices, and other related standards ... to assist the FAA in developing guidance material for AM certification.”

#### CURRENTLY:



**300+ members** from **15 countries**



Membership includes **aircraft, spacecraft, & engine OEMs, material suppliers, equipment suppliers, Tier 1 & 2 suppliers, service providers, defense agencies, and regulatory authorities**



**14 specs** and **2 guidance documents** under development

---

## WHY IT'S IMPORTANT

SAE Aerospace Material Specifications (AMS) support the certification of aircraft and spacecraft critical parts by protecting the integrity of material property data and providing traceability within the supply chain. Industry consensus specifications for additive manufacturing of aerospace parts are an enabler for the migration from part qualification to material qualification. Key principles addressed by AMS specifications include:

- Establishing appropriate requirements and controls to ensure quality and consistency of final product
- Providing statistically derived specification minimum values for the purchase of consistent material and the validation of AM processes
- Enabling public material property databases with verifiable pedigree
- Promoting the fabrication of consistently repeatable AM parts

In order for structural parts produced by AM processes to move from point design to material qualification, the materials and processes used to manufacture AM components must be under documented control. SAE's AMS-AM Committee is developing a series of feedstock material and AM processing specifications required to support regulations governing the certification of aircraft. An integral part of specification development is deriving specification minimum values for the acceptance of feedstock material and the qualification of AM processes.



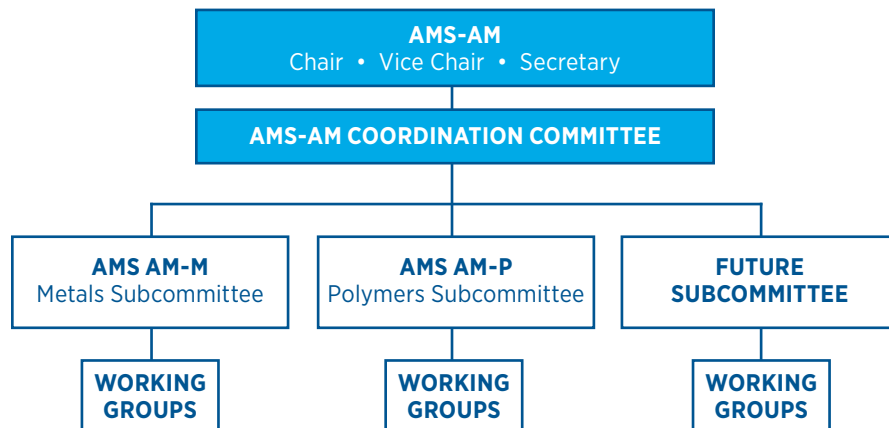
**“THE INDUSTRY CONSENSUS STANDARDS THAT SAE IS GENERATING THROUGH ITS AMS-AM COMMITTEE GREATLY FACILITATE THE IMPLEMENTATION OF ADDITIVE MANUFACTURING IN THE AEROSPACE SECTOR. BY ESTABLISHING THE APPROPRIATE LEVEL OF RIGOR AND CONTROL, THE SPECIFICATIONS WILL ENSURE BOTH QUALITY AND CONSISTENCY IN AM PRODUCTS AND SERVICES.”**

**Dave Abbott**, SAE AMS-AM Chair and Principal Engineer, GE Additive

# SAE'S ADDITIVE MANUFACTURING COMMITTEE

Established in July 2015, SAE AMS-AM, Additive Manufacturing, is a technical committee responsible for developing and maintaining aerospace material and process specifications for additive manufacturing, including precursor materials, additive processes, system requirements and post-build materials, pre-processing and post-processing, nondestructive testing, and quality assurance.

## AMS-AM ORGANIZATIONAL STRUCTURE



## AMS-AM COMMITTEE OBJECTIVES:

- Develop Aerospace Material Specifications (AMS) for the procurement of additive precursor and manufactured materials including metals, plastics, ceramics, composites, and hybrids made by additive technologies.
- Publish technical reports for processing and fabrication of aerospace end products from AM materials.
- Further the adoption of industry sponsored material specifications through coordination with Metallic Materials Properties Development and Standardization Handbook (MMPDS), Composite Materials Handbook (CMH-17), ASTM Committee F42 on Additive Manufacturing, AWS D20, Nadcap Welding Task Group, other AMS committees and associated organizations.
- Establish a system to ensure material specifications are controlled and traceable to statistically substantiated data analyzed by documented procedures.

**“THE SAE AMS-AM COMMITTEE IS COMPRISED OF A GROUP OF INDUSTRY EXPERTS WITH DEEP KNOWLEDGE OF BOTH ADDITIVE MANUFACTURING AND AEROSPACE. EVERYONE IS HIGHLY FOCUSED ON DEVELOPING AEROSPACE SPECIFIC AM STANDARDS THAT WILL HELP THE AEROSPACE INDUSTRY ADOPT AM AT SCALE.”**

**Annie Wang,**  
Vice Chair of the  
Data Management  
Sub-Committee  
and President  
of Senvol

## SAE Initial AM Specification

AMS4999, *Titanium Alloy Direct Deposited Products 6Al - 4V Annealed*, released in 2002, revised in 2011.



## STANDARDIZATION PROJECTS

SAE AMS-AM subcommittees are developing material specifications for the procurement of both metallic and polymer additive precursor and manufactured materials. Process specifications with sufficient controls and traceability for safety-critical parts are also under development.

The Polymer Additive Subcommittee was created at the request of the International Air Transport Association (IATA) Engineering & Maintenance Group.

SAE's AMS-AM Data Management Subcommittee is preparing Data Submission Guidelines describing the minimum data requirements necessary to generate specification minimum values for both metals and polymers.

### Works in Progress – Polymer Subcommittee

Project	Title
AMS7100	Fused Filament Fabrication Process
AMS7100/1	Fused Filament Fabrication - Stratasys Fortus 900mc Plus with Type 1, Class 1, Grade 1, Natural Material
AMS7101	Material for Fused Filament Fabrication

### Works in Progress – Metals Subcommittee

Project	Title
AMS7000	Laser-Powder Bed Fusion (L-PBF) Produced Parts, Nickel Alloy, Corrosion and Heat-Resistant, 62Ni -21.5Cr - 9.0Mo - 3.65Nb Stress Relieved, Hot Isostatic Pressed and Solution Annealed
AMS7001	Nickel Alloy, Corrosion and Heat-Resistant, Powder for Additive Manufacturing, 62Ni - 21.5Cr - 9.0Mo - 3.65 Nb
AMS7002	Process Requirements for Production of Powder Feedstock for Use in Laser Powder Bed Additive Manufacturing of Aerospace Parts
AMS7003	Laser Powder Bed Fusion Process
AMS7004	Titanium Alloy Preforms from Plasma Arc Directed Energy Deposition Additive Manufacturing on Substrate-Ti6Al4V-Stress Relieved
AMS7005	Plasma Arc Directed Energy Deposition Additive Manufacturing Process
AMS7006	Alloy 718 Powder
AMS7007	Electron Beam Powder Bed Fusion Process
AMS7008	Powder, Hastelloy X
AMS7009	Additive Manufacturing of Titanium 6Al4V with Laser-Wire Deposition - Annealed and Aged
AMS7010	Laser-Wire Directed Energy Deposition Additive Manufacturing Process



## PARTNERSHIPS & COLLABORATIONS

- Shared material property databases - CMH-17 and MMPDS
- Regulatory Authorities - civilian aviation, spacecraft, and defense agencies
- Liaisons with ASTM F42, AWS D20
- Participation in America Makes & ANSI Additive Manufacturing Standardization Collaborative (AMSC)

---

For additional information on SAE's AMS-AM Committee, please email [additivemanufacturing@sae.org](mailto:additivemanufacturing@sae.org) or phone SAE Customer Service at +1-877-606-7323 (U.S. and Canada) or +1-724-776-4970 (outside U.S. and Canada).

---

## INTERESTED IN HELPING TO DEVELOP INDUSTRY STANDARDS?

Participation on the SAE International's AMS-AM Committee is open to individuals from aircraft and spacecraft manufacturers, engine manufacturers, material suppliers, equipment suppliers, operators, regulatory authorities, Tier 1 & 2 suppliers, service providers, and research organizations.

If you are interested in participating, please complete the Committee Participation Request form at [sae.org/standardsdev/participationReq/](http://sae.org/standardsdev/participationReq/).

### UPCOMING MEETINGS

- Virtual monthly meetings
- April 23-26, 2018  
Hønefoss, Norway
- October 15-18, 2018  
Wichita, Kansas, U.S.



## **NORTH AMERICA**

### **Warrendale, PA, USA - Headquarters**

400 Commonwealth Drive  
Warrendale, PA 15096  
**p** +1.724.776.4841

### **Troy, MI, USA**

755 West Big Beaver, Suite 1600  
Troy, MI 48084  
**p** +1.248.273.2455

### **Washington, DC, USA**

1200 G Street, NW, Suite 800  
Washington, DC 20005  
**p** +1.202.281.5844

## **EUROPE**

### **Brussels, Belgium**

280 Boulevard du Souverain  
1160 Brussels, Belgium  
**p** +32.2.789.23.44  
**e** [info-sae-europe@associationhq.com](mailto:info-sae-europe@associationhq.com)

### **London, UK - SAE Aerospace Standards**

1 York Street  
London  
W1U 6PA, United Kingdom  
**p** +44.207.034.1250

## **ASIA**

### **Shanghai, PRC**

Room 2503, Litong Plaza,  
No. 1350 North Sichuan Road, Hongkou  
District  
Shanghai, 200080, P.R. China  
**p** +86.21.6140.8900