Alvant

ALVANT MEDIA KIT: ABOUT AMCs

Aluminium-based Metal Matrix Composites: Stepping into the middle-ground between unreinforced metals and carbon composites

For lightness, stiffness and strength, aluminium matrix composites (AMCs) are an advanced composites material reinforced with fibres or particles, which provide sustainability and enhanced capability.

Advanced composite materials combine the properties of high strength, high stiffness and low weight with the potential for enhanced damage tolerance whilst maintaining specific thermal and electrical properties. These composites are classified according to the material being reinforced, with reinforcements typically taking a long fibre, short fibre, or particle form. Hence Metal Matrix Composites (MMCs) are metallic materials reinforced with a secondary high-performance material. Alvant specialises in Aluminium Matrix Composites (AMCs).

AMCs first became known in the 1980s primarily for their use in automotive components. At this time AMCs were in their infancy, their properties largely unproven and sometimes over-sold. As a consequence, the reputation of AMCs suffered, and as carbon composites became more widely adopted AMCs were largely forgotten. In the three decades since, however, research and development into the manufacturing of AMCs has resulted in game-changing progress. This means their stiffness, strength, density, thermal, and electrical properties can be tailored where higher performance is needed.

To manufacture AMCs, Alvant uses various reinforcement formats and architectures to precisely conform to a specific design and to meet exact mechanical and structural requirements.

Unique, patented manufacturing process

Elements of Alvant's unique manufacturing process, Advanced Liquid Pressure Forming (ALPF), are the subject of patents. Alvant has particular expertise in long fibre reinforced AMCs but can also use its Intellectual Property and know-how to develop particle or fibre 'whisker' reinforced AMCs.

Components can be fully manufactured from AMC or can have AMC material selectively applied in a process known as hybrid-AMC. This can provide optimised performance for a more cost-effective solution.

An alternative to typical metal alloys and polymer composites

AMCs are suitable for applications where typical metal alloys are expected to approach or exceed their performance limits. AMCs possess the strength of steel at less than half the weight. Benefits of AMCs over typical metal alloys include greater strength, higher stiffness, reduced weight, better wear resistance, and a tailorable coefficient of thermal expansion and electrical conductivity.

Advantages of using AMCs rather than fibre reinforced polymer materials, such as carbon composite, include higher transverse strength, and stiffness, better retention of properties at high temperature, no moisture absorption, fire resistance and improved damage tolerance. AMCs' strengths in the x-, y- and z-axes, as well as giving performance advantages, also allow greater freedom in design.

The capabilities of AMCs mean they have uses in a wide range of engineering applications. They are particularly attractive for products that are rated against mobility, sustainability, performance and precision with a high level of safety and reliability. It is in defence, aerospace and other forms of niche transport where AMCs will likely be applied in the largest quantities, but AMCs are equally suitable for consumer, energy, industrial and healthcare applications which need to be light, strong and capable of sustaining damage. To give just some examples, products such as mobile devices, electric motors, suspension systems, robotics, sporting equipment, unmanned aerial vehicles, high voltage batteries, biomechanical prosthetics, wheelchairs, bicycles and other luxury items can benefit.

The advantageous material properties of AMCs

AMCs have a number of advantages over alternative materials which might be considered for the same types of application. The table below quantifies the key advantages of continuous-fibre-reinforced AMCs (CFR-AMCs)

Density	3.4 g/cm³	AMCs have much greater strength than steel at less than half the weight.
Longitudinal		
Youngs modulus	250 GPa	This measure of stiffness indicates the material's ability to resist deformation under load. AMCs perform better than most grades of steel
Ultimate tensile strength	1230 MPa	The amount of force AMCs can take before failure is double that of structural steel.
Compressive modulus	250 GPa	Compared to unidirectional high-modulus carbon fibre AMCs have greater stiffness under compression
Compressive strength	1530 MPa	The compressive strength of AMCs is greater than that of carbon fibre .
Youngs modulus at 250°C	230 GPa	The stiffness of AMCs is reduced only fractionally at high temperature, whereas the stiffness of most carbon composites greatly diminishes at approximately 125°C.
Ultimate tensile strength at 250°C	1150 MPa	The strength of AMCs is reduced only fractionally at high temperature, whereas carbon fibre loses much of its strength at about 125°C.
Transverse		
Youngs modulus	160 GPa	Stiffness in this direction is far greater than that of carbon fibre.
Ultimate tensile strength	150 MPa	Strength in this direction is also far greater than in carbon fibre .

Values shown are typical properties for a 60% volume fraction of reinforcement to aluminium matrix material.

AMCs can be 50 percent stiffer than carbon fibre (unidirectional carbon-epoxy composite) in the longitudinal direction, and close to three times as strong in the transverse direction.

AMCs retain their properties at high temperatures, unlike carbon fibre, making them better-suited to high service temperature components in aerospace, defence, automotive, electronic and industrial applications.

AMCs also have similar fatigue response to steel. This means AMC components could replace high stress, high cycle steel components for a significant weight saving

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