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Additively Manufactured Lattice Provides Reinforcement for Composite Structures

Stress-resistant structure increases strength, reduces overall weight, promotes fluid permeability, prevents air pockets, and maximizes internal volume

Typical airborne munition casings are hollow cylinders formed using strong metals or carbon fiber composites, and then filled with explosive material. The metal casings are strong and resist premature rupturing, and the carbon fiber composites reduce overall weight at comparable metal strengths. However, limitations exist with each solution. Structural support for each cylinder comes only from the casing. Metal casings are heavy, limiting the amount of material contained therein. Carbon fiber composite casings achieve comparable strength with thicker walls, and at the expense of internal volume.Scientists at the Air Force Research Lab Munitions Directorate (AFRL/RW) invented a new solution addressing both aforementioned limitations. The invention, similar in concept to a bridge truss, incorporates an internal fluid as part of the casing support and keeps weight to a minimum. Using a triple periodic minimal surface, or TPMS, this technology attaches to the inner surface of a cylindrical tube. Its lattice-like cavities allow viscous materials to permeate while preventing air pockets. Filling its cavities with viscous material adds further stiffness to the structure.This lattice insert can be customized as well. The geometry of the lattice—including surface smoothness, wall thickness, or type of TPMS structure—can be modified for desired mass or performance characteristics. Other types of TPMS structures which can be used successfully include Schwartz primitive, a Schoen grid, and a Schwartz diamond.This advancement could see use in consumer products such as generic cross-flow heat exchangers, bicycles, and automobiles; as well as heavy industrial uses like pilings and high-velocity penetrating structures. Moreover, it adds value to safety items in which the internal contents are subject to vibration, shock-induced forces; long-duration compressive, bending, or torsional forces; chemical unit operations such as continuous flow reactors (plug flow), and catalytic design.

An isometric view illustrating additively manufactured triply periodic minimal surface, or TPMS.

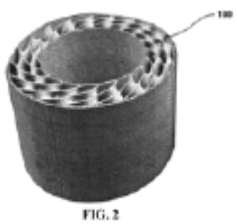

FIG. 2

BENEFITS

Increased stiffness-to-weight in compression, twisting, and bending strength

Reduced structural mass

Increased usable internal volume

Maintains original structural properties of composite structure alone

Better bonding between the lattice and composite structures

OPPORTUNITIES

US patent 10,871,355 available for license

Collaboration with Air Force researchers

Potential for:
Chemical Plants
Construction
Space Vehicles
Mining & Drilling
Bicycles
Automotive

READY TO COLLABORATE?

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