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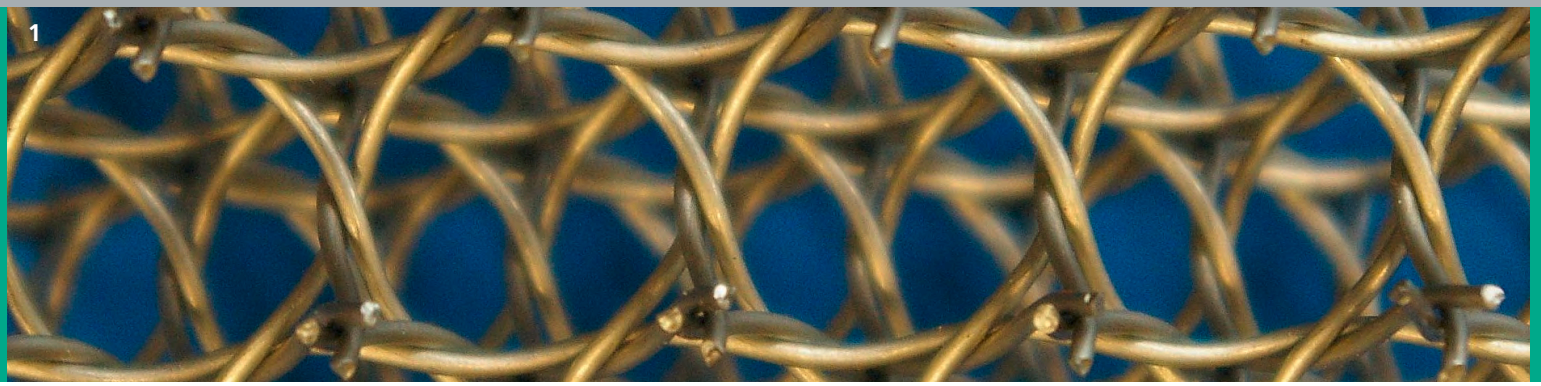

1 *Close-up of a 3D wire structure*

THREE-DIMENSIONAL WIRE STRUCTURES

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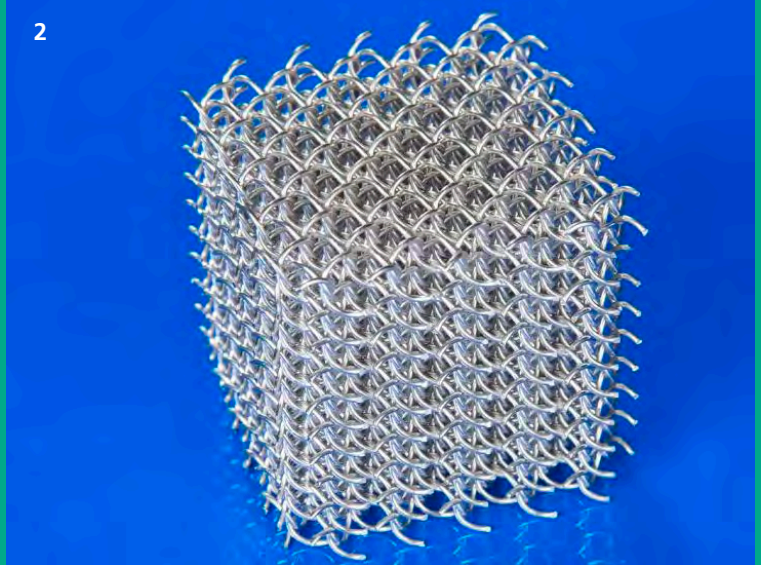
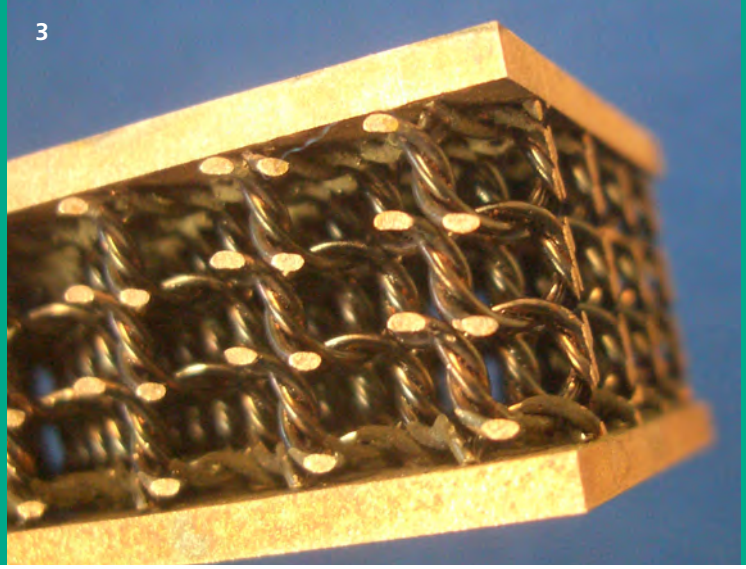
The reduction of weight in vehicles, machines and equipment is essential to save resources and to decrease the consumption of energy and cost. An important option to fulfil those aims is the development of new lightweight materials.
Cellular materials are interesting candidates for weight-saving due to the fact that the introduction of pores into the materials lowers the density significantly.
These highly porous materials also possess combinations of properties which are not possible to achieve with other materials. Beside the drastic weight and materials savings that arise from the cell structure, there are also other application-specific benefits such as energy and noise absorption, heat insulation, mechanical damping, filtration and catalytic effects. A new type of cellular materials are so-called three-dimensional wire structures which are characterised by a wide range of pore sizes and structural densities.
The 3D wire structures offer new opportunities in the field of lightweight construction especially.

Manufacturing

3D wire structures have been manufactured by assembling spiral-like wires in a systematic way by a specially designed equipment. The machine allows the manufacturing of wire structures based on different wire diameters as well as wire materials. A combination of different wire materials in one structure can be fabricated. The wire cross points or nodes are interconnected by brazing, soldering, adhesive bonding or sintering.





The resulting structure can be isotropic or anisotropic. By applying additional processing steps, sandwich structures and other composites are available.

Materials

- Low and high alloy steels
- Aluminium and copper based alloys
- Titanium based alloys
- Nickel based superalloys
- Carbon fibers

Properties

3D wire structures are characterized by their low density which can be tailored in a wide range (0.1 - 1.5 g/cm³). The pore size reveals a great variability between 2 and 25 mm. The specific mechanical properties are high and can be significantly increased (and tailored) by additional soldering, welding and other procedures to assemble the wire triple points.

Wire structures exhibit a very low thermal conductivity (0.2- 1 W/mK). A further feature is their high performance for the absorption of deformation energy which can be varied in the range of about 10 to 30 MJ/m³.

An additional advantage of 3D wire structures is their good availability for FEM simulation and excellent calculability.

Potential Applications

3D wire structures are excellent candidates for super lightweight construction. For instance wire reinforced castings exhibit a three times higher fracture toughness compared to their unreinforced counterparts. Furthermore, interesting fields of applications are explosion protection and heat exchangers. A new innovation area could be biomaterial where the mechanical requirements of the bone can be adapted by a combination of isotropic and anisotropic wire structures.

Wire sandwich structures can be used for containers as well as multifunctional lightweight elements for building construction. Furthermore, 3D wire structures in combination with phase change materials (PCM) are excellent candidates for high performance heat storage devices.

R&D Services

- Development of 3D wire structures based on different metals and alloys
- Joining of the wire structures by brazing, soldering, gluing and sintering
- Characterization and testing of properties' profile
- Development of complex parts/ prototypes based on 3D wire structures
- Simulation and design of parts
- Manufacturing of prototypes and small scale production

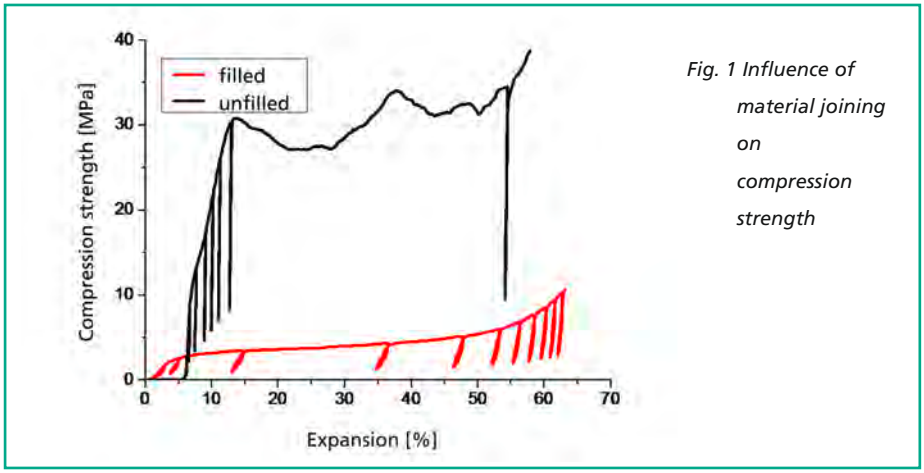


Fig. 1 Influence of material joining on compression strength

2 *Sample 3D wire structure*

3 *Sandwich structure with 3D wire structures*