**Cryogenic and high temperature behavior of metal foam matrix composites (MFMCs) under static and impact compression loads**

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**Abstract:**

Compared to fully dense solid metals, porous metallic foams are a new class of ultra-lightweight structural materials that are highly valued in recent years in many crucial engineering fields (such as aircraft, spacecraft, vehicle and buildings). All these applications are due to their excellent performances in energy absorbing and mechanical damping. Actually, owing to their wide range of applications, these composite materials are used under different loading conditions and at different temperatures [1].

Different lightweight and less expensive advanced composite structures capable of low and high temperature operation are also required for many future space exploration missions (and not only). Some typical cold and hot environmental temperatures, applicable for our solar system, are [2-5]:

* the chilly night side of the Mercury (-180°C),
* Moon Titan surface temperature (-180°C),
* Moon Europa Icy surface temperature (-188C to -143°C),
* the rings of Saturn (-185C),
* the lowest temperature on Earth (Antarctic Plateau -89.2°C),
* the highest surface temperature on Earth (Lut Desert-Iran 70.7°C),
* Venus atmosphere (150°C between 40 and 48 km altitude and 325C at 18 km altitude),
* the day side of the Mercury (377°C),
* the highest part of Terra Ishtar (380°C).

In practice, the effects of low and high temperatures, on the composites mechanical behavior, cannot be ignored because porous (foams) materials are very sensitive to temperature changes. Therefore, understanding the mechanical behavior of such cellular materials under extreme atmospheric conditions (from cryogenic to high temperatures) is very important and critical for exploring their suitability for constructing lightweight foam composite structures used in space, arctic and desert explorations. According to author’s knowledge, up to now there are no literature that discusses the compressive mechanical properties of metal foam matrix composites (MFMCs) at subzero and high temperatures. Foaming technique for manufacturing of MFMCs was used [6]. Therefore, this paper experimentally investigates the simultaneous effect of the different: (i) sample configurations (without reinforcements and with two different positioning of reinforcements), (ii) loading conditions (quasi-static and impact loads) and (iii) temperatures (-196, -75, -25, 0, 25, 75, 150, 250 and 350°C), on compression mechanical response. Also, some samples have been maintained both in an arctic (-75 and -25°C) and desert (75°C) environment for a period of 60 days; and then tested at room temperature, as well as in-situ 75°C. The conditioned and unconditioned results obtained were then compared. Moreover, a correlation between macrostructure, microstructure and stress-strain curves was carried out in terms of brittle or ductile behavior. Also, the collapse mechanisms together with energy absorption performances were presented.

**Keywords:**

metal foam matrix composites, cryogenic and high temperature, static and impact loading, mechanical properties, energy absorption.

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