In-situ microscopic and macroscopic mechanics of flexible silica aerogels

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Abstract

Aerogels are lightweight, open-porous materials, that exhibit high specific surface area and low thermal conductivity (1). Among the different types of aerogels, the super flexible silica aerogels exhibit advantageous material characteristics with regards to their mechanical behaviour for practical applications (2). Moreover, a modification of the density of flexible silica aerogels allows for increased lightweight characteristics without a considerable reduction in heat insulation efficacy (3). However, there is a lack of knowledge regarding the mechanical behaviour and damping properties of flexible silica aerogels, particularly with regard to their suitability for low-temperature insulation necessary for aerospace and hydrogen applications.

In order to address these challenges, this study aims to provide insights into the micro- and macroscopic behaviour of flexible silica aerogels using computer tomography (CT) and dynamic mechanical analysis (DMA). Flexible silica aerogels of different densities were developed using moulds and shaping of geometries needed for testing was facilitated by the use of razor blades. Resulting geometries were scanned and measured using 3D-scanning technology. In-situ CT is employed while the aerogels undergo compressive loading to track the variation in pore size distribution across the aerogels specimen as a function of compressive strain. Additionally, compression tests were conducted using DMA, which has been employed for non-flexible silica composites previously (4, 5), to examine the mechanical and damping characteristics as a function of temperature and frequency. These combined findings have the potential to accelerate the advancement of flexible aerogel development and facilitate their practical implementation in low-temperature aerospace and insulation applications.

References:

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