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Out-of-plane compression of Ti-6Al-4V sandwich panels with corrugated channel cores

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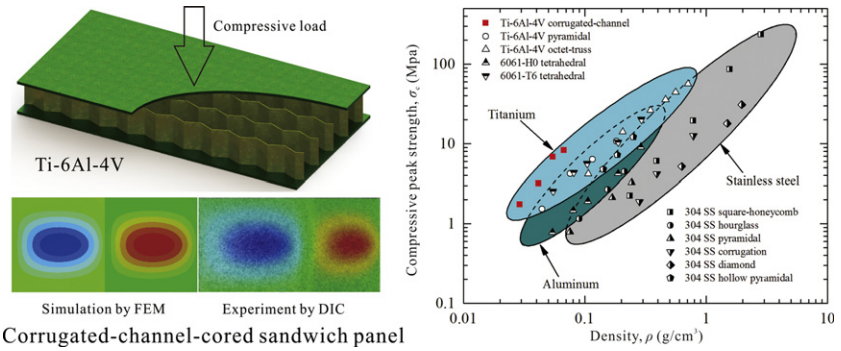
HIGHLIGHTS

- Novel corrugated channel cores are discovered for multifunctional sandwich constructions.
- Corrugated channel cores outperform competing sandwich cores in low density regime.
- Ratio of core web spacing and corrugation amplitude sharply affects compressive response.

GRAPHICAL ABSTRACT



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ABSTRACT

A novel sandwich core topology – corrugated channels (periodic fluid-through wavy passages) – was proposed for simultaneous load-bearing and active cooling applications. Relative to a sandwich panel with parallel plate channels, the sandwich with corrugated channel core exhibits not only significantly enhanced convective heat transfer rate but also superior mechanical performance. To explore the underlying deformation and failure mechanisms, corrugated-channel-cored sandwich panels (3CSPs) with low relative densities (<1.5%) were manufactured, with Ti-6Al-4V alloy used as the constituent material for both the core and the face sheets. The quasi-static, out-of-plane compressive behaviors of Ti-6Al-4V sandwich panels were systematically studied using a combined experimental, analytical and numerical approach. The compressive strength of the proposed 3CSP was also compared with competing core topologies on the material selection map. With superior structural and thermal efficiency, the corrugated channel core is promising for a wide variety of multifunctional lightweight sandwich constructions.

1. Introduction

Recent developments in all-metallic sandwich constructions have focused not only on searching for even lighter load-bearing structures such as novel periodic lattice cores, but also on pursuing further functionalities such as simultaneous load-bearing and heat dissipation [1]. A variant of lattice cores have thus been proposed to explore such

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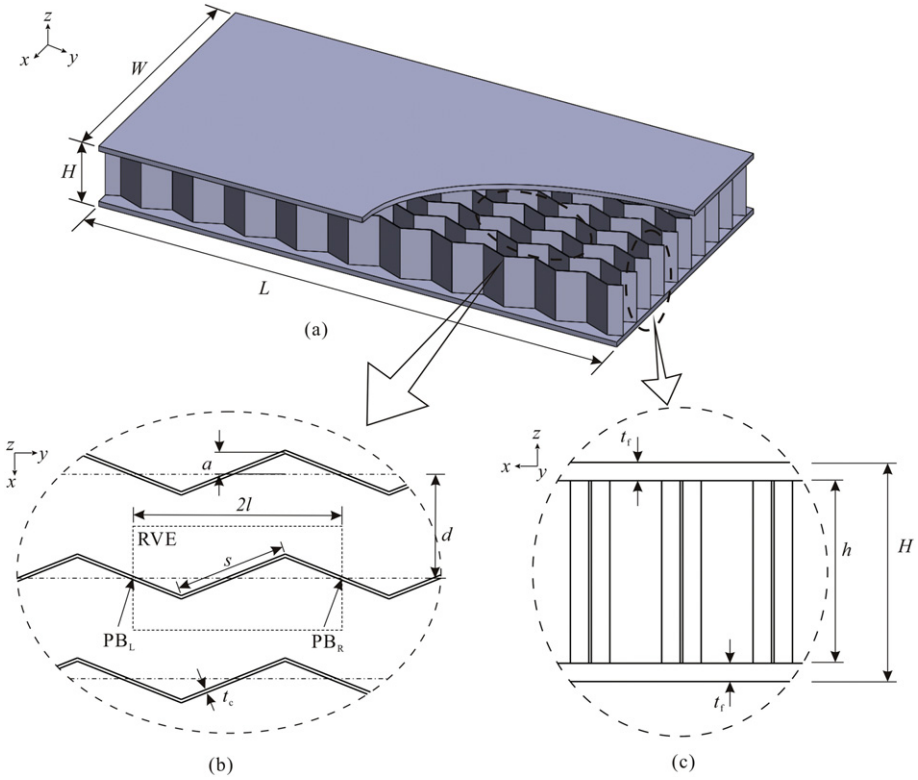

Fig. 1. (a) Schematic of sandwich panel with triangular corrugated channel core; (b) top view and (c) side view. Representative volume element (RVE) with periodic boundary conditions (PB_L and PB_R) for finite element simulation was marked by dashed lines in (b).

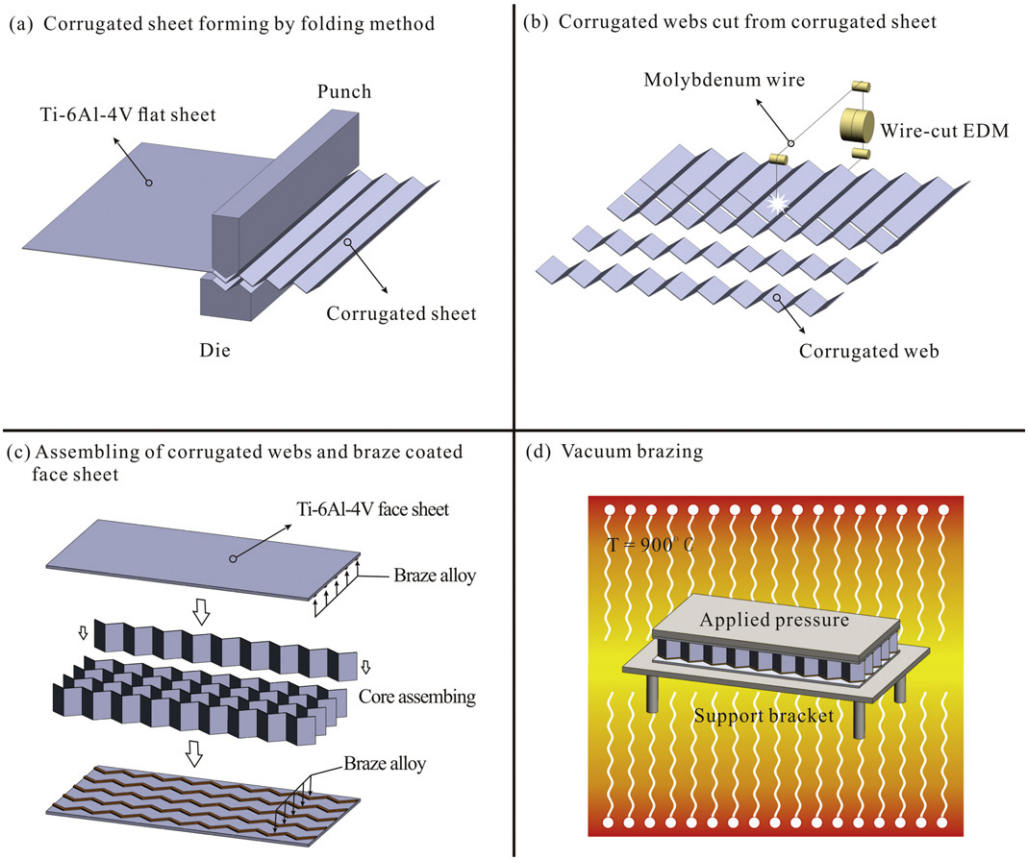

Fig. 2. Fabrication of triangular corrugated-channel-cored sandwich panel: (a) folding of corrugated sheet; (b) fabrication of corrugated web; (c) assembling of sandwich panel; (d) vacuum brazing.