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Broadband microwave-absorbing honeycomb structure with novel design concept

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In this study, a novel broadband microwave-absorbing honeycomb structure is designed using a new concept and is fabricated. To efficiently improve the absorbing performance, the proposed novel design concept uses the transverse direction of a honeycomb structure made out of a lossy material. In that the honeycomb structure can be used in the transverse to the ribbon direction, the effective thickness in terms of the incident EM waves becomes very large, resulting in the enhancement of absorption bandwidth. The designed absorbing honeycomb structure was fabricated using glass/epoxy-MWCNT prepregs and the autoclave process. The measured absorbing performance of the fabricated absorbing honeycomb structure using a free-space measurement system satisfied −10 dB absorption from 3 GHz to 16 GHz. When the performance of the absorbing honeycomb structure is considered in terms of the absorbing bandwidth, because most tracking radars use the C band and/or the X band due to their resolutions, the verified return loss of the absorbing honeycomb structure was found to be superior. It was shown that a lightweight and broadband absorber could be implemented without the use of a magnetic material and without limitations on the thickness.

1. Introduction

Microwave absorbing composite structures which are simultaneously load-bearing and incident wave absorbing have been intensively studied [1–6]. However, most of the reported microwave absorbing composite structures has narrow operating frequency bands.

Recently, researches on decreasing the advantages of stealth technologies, referred to as counter stealth, are actively progressed in the military area. Since stealth technology had mostly been focused on defeating monostatic radar systems of narrow frequency bands, broadband or low frequency radar have become significant threats for conventional stealth aircraft [7]. In that case, when the frequency band is changed to the other frequency bands, the matching point is deviated from the optimal design and as a result, the absorbing performance is greatly degraded. If such technology trends are considered, the microwave absorbing composite structures reported so far still have some disadvantages and limitations in terms of bandwidth.

Generally, to implement microwave absorbing composite structures, non-magnetic materials are used [1–6]. Since mechanical properties are greatly influenced by fillers, non-magnetic materials such as carbon black, MWCNT, or graphene, which modifies the electrical properties with low filler contents [8] and acts positively in strength and stiffness [8–12], are used primarily.

To obtain a wide absorption bandwidth in microwave absorbing structures using non-magnetic materials, large thicknesses are required [13]. However, thick microwave absorbing structures are not feasible for aircraft due to the weight increase. Although the bandwidth can be enlarged by using magnetic materials, such methods usually rely on a very high wt% of the magnetic materials for sufficient absorption performance [14,15]. However, such methods are also accompanied by weight increases and degrade the mechanical properties due to its high wt% and particle size.

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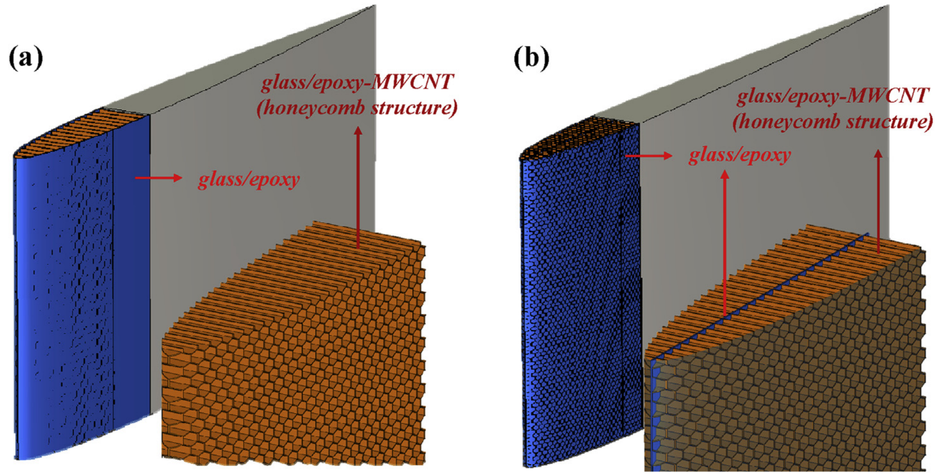

Fig. 1. Wing-shaped structure with microwave absorbing honeycomb structure arranged transversely in terms of incident waves: (a) without supporting facing sheet and (b) with supporting facing sheet at the center of leading edge part.

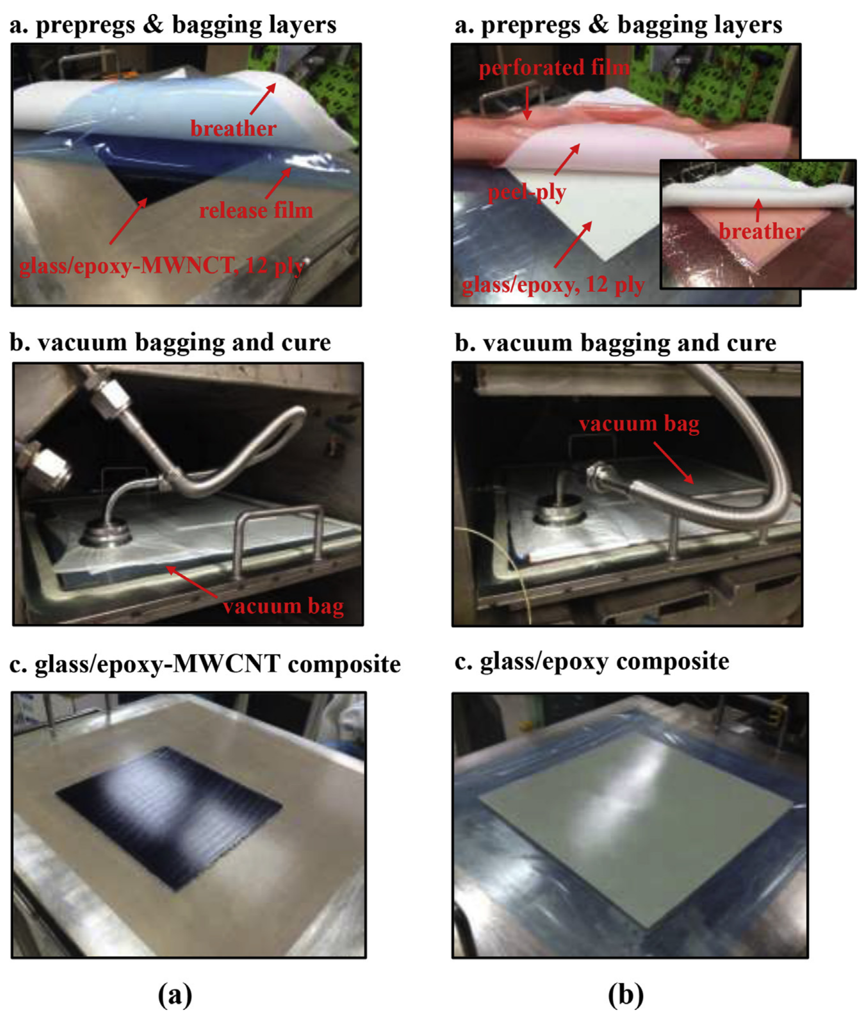

Fig. 2. Fabrication process for (a) glass/epoxy-MWCNT 1.8 wt% composite without resin extraction and (b) glass/epoxy composite.