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APPLYING THE CARBON NANOFILLERS WITH DIFFERENT DIMENSIONALITIES TO IMPROVE THE POST-IMPACT COMPRESSIVE FATIGUE RESISTANCE OF CARBON FIBER REINFORCED EPOXY COMPOSITES

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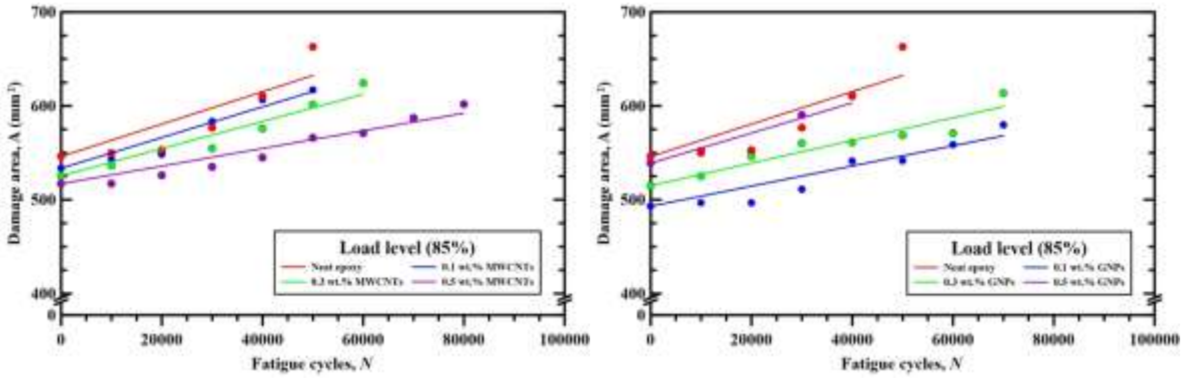
ABSTRACT

The effect of dispersing multiwalled carbon nanotubes (MWCNTs) and graphene nanoplatelets (GNPs) in the matrix on the post-impact compressive monotonic and fatigue strengths of carbon fiber reinforced epoxy composites has been experimentally studied in the study. The composite specimens with the matrix reinforced by different nanoparticle concentrations of two employed carbon nanoparticles, i.e., 0, 0.1, 0.3, and 0.5 wt.% were prepared to study the effect of nanoparticle content on the impact resistance and post-impact compressive monotonic and fatigue damage tolerance. The impact tests were performed using a drop-weight impact tester at the impact energy of 60 J. The damage area of the specimens was determined by image processing the infrared thermal image. Experimental results show that the optimum contents of the employed nanoparticles for the impact resistance, such as impact force, damage area, indentation depth, are 0.5 and 0.1 wt.% for the MWCNTs and GNPs, respectively. Furthermore, the composite specimens with 0.5 wt.% MWCNTs and 0.1 wt.% GNPs have higher post-impact compressive strengths compared to the ones with other concentrations of nanoparticles.

For the post-impact fatigue behavior, the post-impact specimens were compressively fatigue-tested at 85% load levels. The evolution of damaged area was recorded at fixed cycle intervals using the infrared thermal imager. As shown in Figure 1, the experimental results show that the damage area increases with the fatigue cycles. A linear model can be employed to describe the relationship between damage area and fatigue cycles, and the damage area growth rates can be obtained from the fitting data of the applied model. Figure 2 shows the variation of damage area growth rate with the applied nanofiller concentrations. The results show that the composite specimens with 0.5 wt.% MWCNTs and 0.1 wt.% GNPs have lower damage growth rate than the ones with other contents of MWCNTs and GNPs, respectively. The pull-out/bridging effects of one-dimensional nanofillers (MWCNTs) and the crack deflection effect of two-dimensional nanofillers (GNPs) increase the toughness of the polymer matrix, and further enhance the impact resistance and damage tolerance of the studied composite specimens. However, the agglomeration caused by applying excess GNPs decreases the impact resistance and post-impact fatigue tolerance of the studied composites significantly.



(a) (b)

Figure 1: The relationships between the damage area and the fatigue cycles for the composite specimens reinforced by (a) MWCNTs with various concentrations and (b) GNPs with various concentrations.

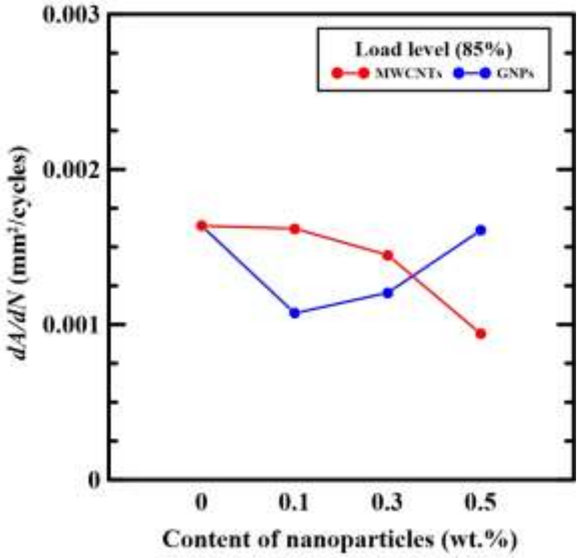


Figure 2: Variation of damage area growth rates with the contents of applied nanofillers.