" Mechanical performance of laminted composites based carbon nanotubes at high strain rate "

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Résumé:

Les propriétés dynamiques des composites stratifiés renforcés par des nanotube de carbones ont été déterminées à l'aide des barres d'Hopkinson en traction. Le composite est constitué de fibres de carbone renforcé par un film mince d'époxy et de nanotube de carbone. Différentes fractions massique de nanotubes ont été utilisées à savoir: 0%, 0,5%, 1% et 2%. Les essais expérimentaux ont été réalisés dans différentes plages de vitesses de déformation. La variation des propriétés mécaniques en fonction du pourcentage de nanotubes a été déterminée. La déformation de l'échantillon a était contrôlée par une caméra rapide.

1. Introduction

Graphene and carbone nanotubes (CNTs) are the carbon additive with excellent mechanical properties and have been extensively employed as reinforcement in composites [1, 2, 3]. In the last few years, there have been a number of studies on the characterization of the dynamic tensile response of composites reinforced with carbon nanotubes [4, 5]. They observed that the carbon additives enhanced the impact properties and limited the damage size in the composite.

The objective of the present study is to investigate the influence of the nanotubes on the mechanical properties of composite laminates under high strain rates. The mechanical properties at high strain rate were measured by means of Split Hopkinson Tension Bras (SHTB), Figure 1. The composite panels were manufactured using the infusion process, Figure 2. The specimen was fixed with fixture system, Figure 2, and connected with the bars. The pressure wave was generated by impacting a striker bar to input bar. The strain gages record theses wave pulses. A typical signal obtained during experimental setup was presented in Figure 3. This signal was compared for different percentage of CNTs.

2. Experimental approach

2.1. Materials and structures

The materials used in this investigation are: Epon 862 Epoxy resin, T300 6k carbon fibers fabric provided by Hexell and CNTs nanoparticles provided by Nanocyl Belgium. The composite panels were fabricated using the infusion process. The CNTs film was implanted between plies of laminates. Each panel consisted of 12 layers of carbon fiber fabric interleaved with 11 layers of nanocomposites films.

2.2. Experimental tests

Split Hopkinson Tension Bar test was used for the impact characterization. Each test was repeated three times to ensure the reproducibility of results and the averaged curves were obtained. Figure 1 shows the used machine for the dynamic characterization. The test was done on composite specimens with dimensions listed in Figure 2. The percentage of CNTs is ranging between 0.5wt% and 2% and the experimental curves are confronted with the case of 0%.

Figure 1: experimental machine

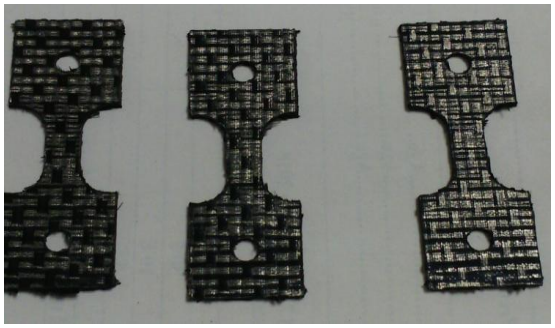
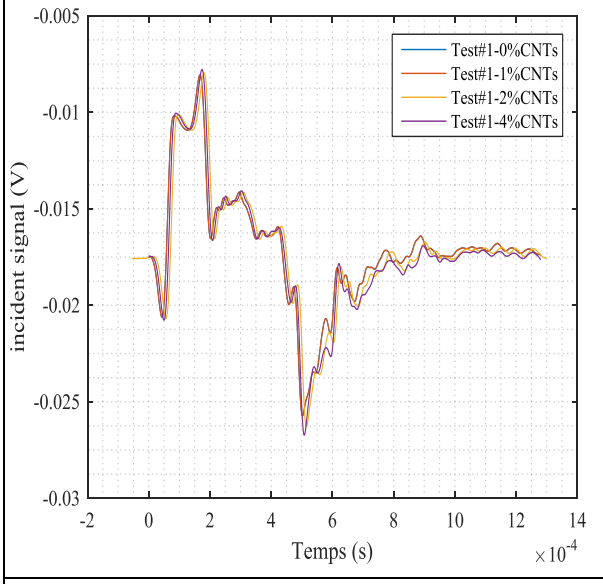


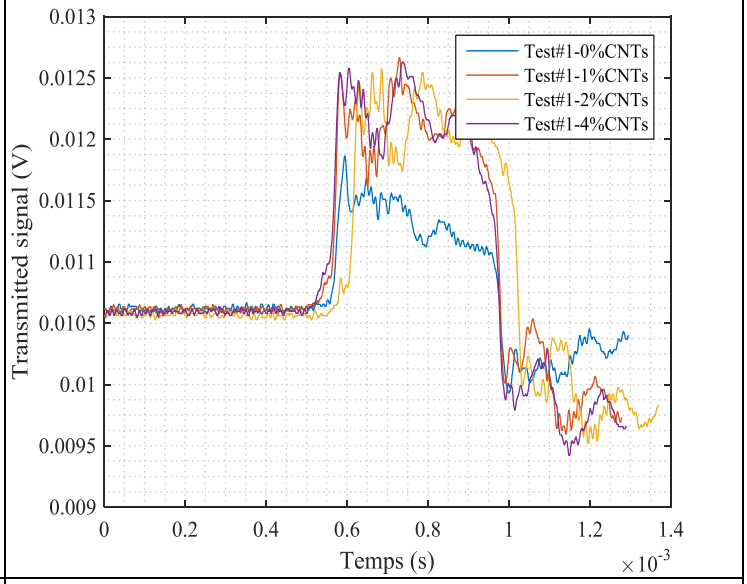
Figure 2 : tested specimens

3. Result and Discussion

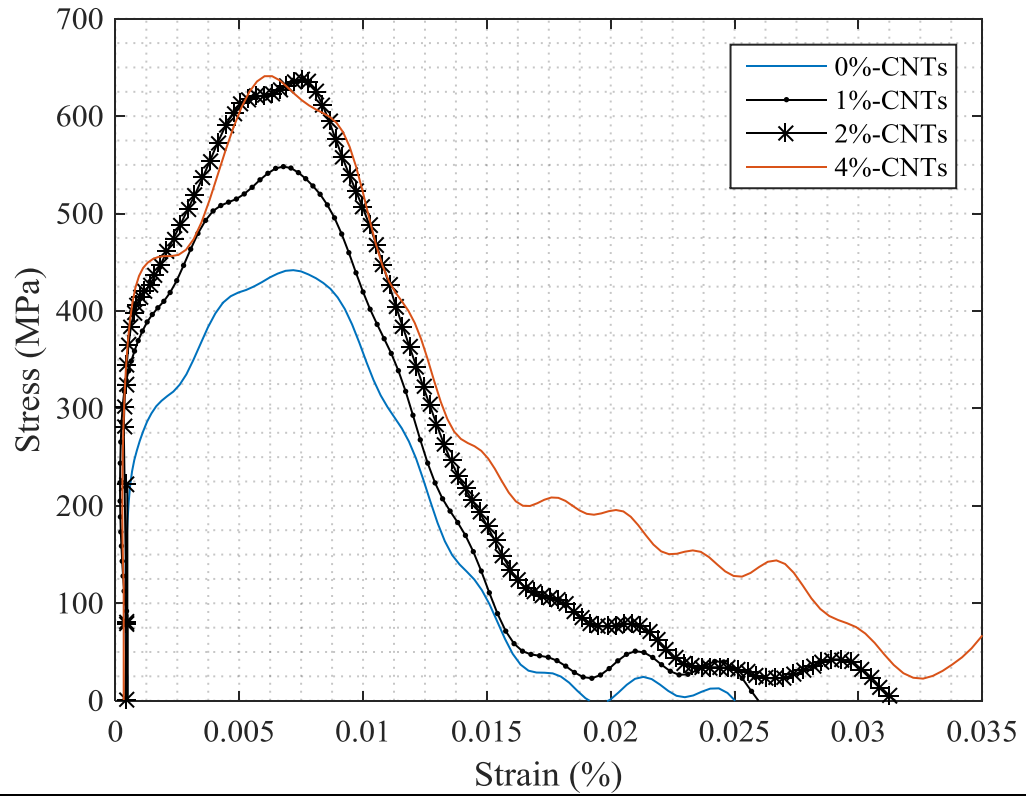
A typical signal obtained during experimental setup was presented in Figure 4. This signal was compared for different percentage of CNTs. It appears that the CNTs nanoparticle does not affect the incident and reflected waves. But the transmitted waves changes with changing the CNTs loading. The average data of the stress-strain curve is presented in Figure 4 for different CNTs fraction. The result indicates that he mechanical properties increase with increasing the CNTs fraction. The maximal stress increases with increasing CNTs.



Incident and reflected waves



Transmitted waves



Stress-strain curves

Figure 4: experimental data of laminate based CNTs at high strain rates.

4. Conclusion

Laminate composites reinforced with CNTs were tested at high strain rate using Hopkinson bars. The fraction of CNTs was ranging from 0 to 2%. The following conclusions are observed:

- Increasing the percentage of nanotubes causes an increase in the maximum dynamic stress and improved the strength of the laminate.

- The addition of nanotubes does not greatly affect the strain associated with the maximum stress.

5. Bibliography

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