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Mechanical properties of Silicone/carbon nanotubes/carbon felt composite

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Abstract – The mechanical behavior of fiber-reinforced composite based on Silicone/CNT/felt composite has been studied using dynamic mechanical analysis. The hybrid matrix composite cup-stacked/felt (CSCNT/felt) and helical/felt were prepared using chemical vapour deposition. The results show that this type of matrix presents an excellent interface for incorporation of silicone. The presence of a small amount of CNTs on the felt is able to provoke large changes in the storage module of the Silicone/CNT/felt. These changes are larger for the cup-stacked than for the helical tubes and depend strongly on the type of CNTs used in the preparation of the matrix.

In several aero-space applications, fiber-reinforced carbon composites have been widely used because of the thermal, mechanical, and electromagnetic conditions often required in this kind of application. One decisive question regarding the performance of these materials in these applications is the quality of the interface between the carbon and the polymer. The use of carbon nanotubes in the preparation of this composite provides a means of controlling the thermal, mechanical, and electro-magnetic properties. However, dispersion of carbon nanotubes in polymers like thermoplastic, silicone, and epoxy-resin is no easy task since carbon nanotubes present strong interactions between them. For this reason, the use of CNT/felt as a matrix for polymers was investigated. The CNTs are bound to each carbon fiber on the felt. The use of CNT/felt as a hybrid composite matrix for the development of polymer composites has been proposed before, but its mechanical properties have never been studied [1]. Here we show the mechanical behavior of Silicone/CNT/felt. The CNT/felt was prepared using chemical vapor deposition; the cup-stacked carbon nanotubes (CSCNT) were obtained using Mn/Co catalyst; and the helical tubes (HICNT) growth was obtained by using Fe as catalyst. All CNT/felts were submitted to purification with HCl. The dynamic mechanical characterization of the composites was carried out by employing specimens with dimensions of 20x2x5 mm in the traction mode, at a frequency of 1 Hz. The samples were heated from –120ºC to 300ºC at a rate of 2ºC min^{-1}. Figure 1 shows the storage and loss modulus for the composites prepared with different loadings. In the case of silicone/felt, silicone/helical/felt and silicone/cup-stacked/felt loading in the samples were 72%, 17%, and 5.8% in total weight respectively. The main alteration was observed when the matrix was prepared with CSCNTs: there was an increase of about 122% in the positive range of temperature with only 5.8% of CSCNT. On the other hand, the changes provoked due to the HICNT were smaller and depended on the temperature range. The helical tubes made the composite softer at low temperatures and slightly reinforced at temperatures up to -22°C. These results showed that the carbon nanotubes have a strong influence on the dynamic mechanical properties of the composites.

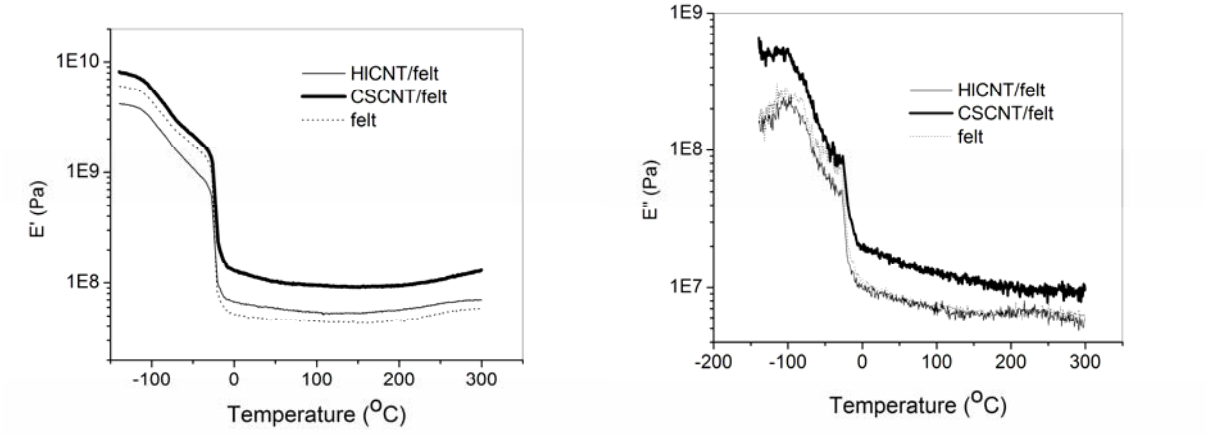

Figure 1: Storage Modulus (E') and Loss Modulus (E") of Silicone/CNT/felt matrices using helical (HICNT) and cup-stacked (CSCNT) tubes.

References

[1] J. M.Rosolen, INPI Patent deposit (2007).