MULTIFUNCTIONAL FIBERS BASED ON POLYAMIDE 6 AND PLASMA FUNCTIONALIZED CARBON NANOTUBES

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Commercial (CNT 1) and *ad hoc* synthesized carbon nanotubes (CNT 2) were plasma treated under oxygen atmosphere and then added to polyamide 6 (PA 6) in order to prepare multifunctional fibres by melt spinning. For comparison, pristine nanofillers were used too. The effect of functionalization and of filler characteristics on the morphological, rheological, mechanical and electrical properties of the fibers was studied by TEM and SEM, rheological measurements, tensile tests and electrical conductivity tests. The amalysis of Raman spectra put into evidence that the intensity of D-band (correlated with the degree of functionalization by the different vibration mode of carbon atoms in the presence of defects[1,2]) increased after plasma treatment, thus confirming the oxidation of nanotubes. The rheological measurements showed that the increments of MS are more intense when CNT 2 are added and when functionalized samples are used. Therefore, the highest increase of melt strength (MS) is observed for the systems PA6/f-CNT 2 while the lowest is observed in the system PA6/CNT 1. These results can be interpreted considering that the presence of polar oxygen moieties in the functionalized CNTs is responsible of a better adhesion between the nanofiller and the matrix. This higher interaction between the two phases causes an increase of the elongational viscosity and, finally, an increase of the MS. In this sense, f-CNT 2>CNT 2≈f-CNT 1>CNT 1. The results carried out from tensile tests followed the same trend observed in the case of MS and demonstrated that the functionalization led to a higher mechanical performance. The morphological analysis confirmed that the adhesion, the dispersion and the alignment of the nanotubes within the polymer matrix were improved when using functionalized CNTs. In PA6/CNT 1, Fig. 1a, it is possibile to identify single nanotubes with smooth surface, evidencing the absence of any adhesion with the matrix. The morphology of PA6/f-CNT 1, Fig. 1b, is different as the nanotubes are partially covered with PA6, indicating a higher affinity between the two components. The adhesion is further improved when using f-CNT 2, Fig. 1c-d. In this case it is possible to see several isolated nanotubes that are wrapped into PA6. This higher affinity between the matrix and CNTs allows their better orientation, as evidenced by the preferential alignment along the drawing direction. Electrical tests marked that functionalization slightly reduced the conductivity of materials and, in general, the effect of the characteristic of filler (L/D, purity) plays the most important role on this property.

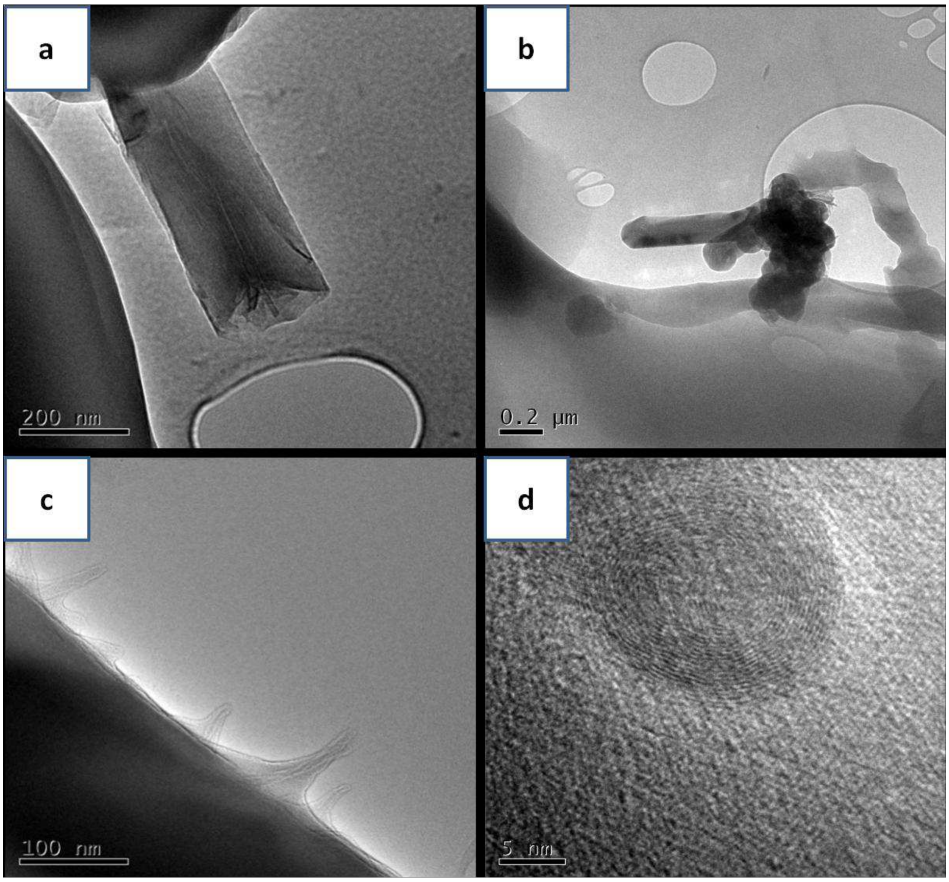

Figure 1 TEM micrographs PA6/CNT 1 (a), PA6/f-CNT 1 (b), PA6/f-CNT 2 (c-d).

References

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