ELECTRICALLY CONDUCTIVE POLYPROPYLENE FIBERS

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Abstract

We report here the development of electrically conductive polypropylene-MWCNT fibers and tapes with conductivities up to 70 S/m.

Electrical conductor fibers and yarns are very desirable kind of materials in nanotechnology. With the rapid development of electrical, and particularly electronics industry, flexible electrically conducting and semi-conducting materials are receiving a widespread attention. These materials are playing a more and more important role in realizing lightweight, wireless and wearable interactive electronic textiles used in Smart Materials. They have also an important role in the development of EMI shielding textiles, which are used to avoid the exposition to electromagnetic waves. This is a particularly important problem to workers that are exposed to electromagnetic sources (such as antennas and power generation) and patients with pacemakers that can be confronted with some specific problems regarding EMI that might interfere with the pacemaker function.

Metallic fibers are expensive, more brittle and heavier than most textile fibers, making it difficult to produce homogenous blends and also they can suffer galvanic corrosion. It is also possible to impart electrical conductivity to commercial fibers by non-metallic conductive coatings. Nevertheless, intrinsically conductive fibers have a major advantage compare with the conductive fibers based on coated yarns because the former can not suffer from delamination, which clearly affects the electrical conductivity.

Using a solution compounding method assisted by sonication we have produced composite master-batches (1Kg/batch) with improved MWCNT dispersion levels. These composites have been extruded into fibers by melt spinning which is a well implemented technique in textile industry that allows mass production of woven textiles. In good agreement with the high dispersion levels observed the conductivity and spinability of the material into fibers were better too.

We have observed a percolation threshold at 0.5% with a maximum conductivity of 70 S/m at 8% wt. The different formulations can be extruded into fibers or tapes due to the small size of the clusters produced after the compounding method. Different stretching rates of the tapes and fibers are obtained depending on the wt % of MWCNT in the composites. In good agreement with previous studies, alignment of the MWCNT along the fiber axial direction has been observed. In fact, alignment degree of MWCNT and deformation of clusters directly depends on the stretching forces applied during the extrusion of the fiber. An extensive characterization of the fiber and materials has been carried out (including SEM, XRD) to describe their internal structure and morphology. Macroscopic properties (MFI, DC and AC conductivities, roughness) have been also studied.

In conclusion, achieving a non-metallic and intrinsically conductive fiber is an appealing challenge with many applications in different fields. The ultrasonication assisted compounding method developed for thermoplastics (such as polypropylene) represents a promising alternative to improve the dispersion of the nanofiller within the polymeric matrices. This is especially indicated for very high end applications where a high performance of the product is expected using the minimum amount of filler necessary. In these particular scenarios, maximizing the outstanding properties of the nanofillers will represent the difference between success and failure.

References

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Figures

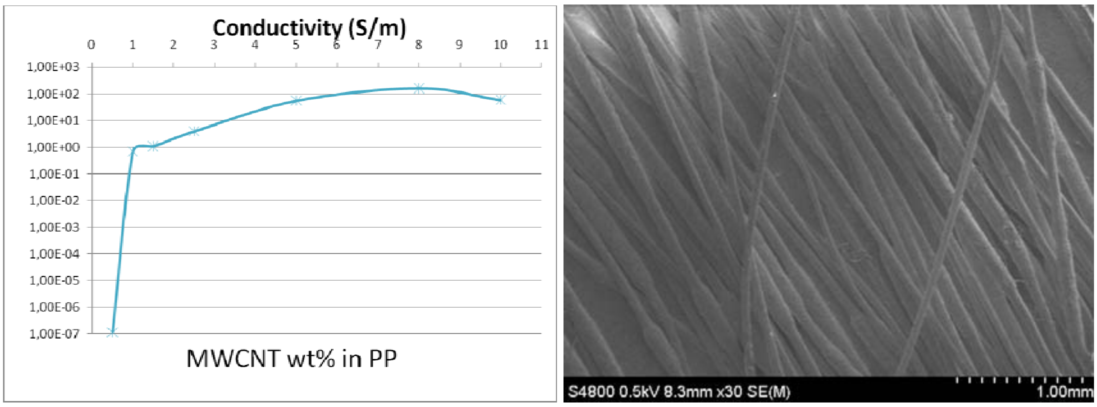

Figure 1: Left: Electrical conductivity vs MWCNT %wt; right: SEM of fibers.

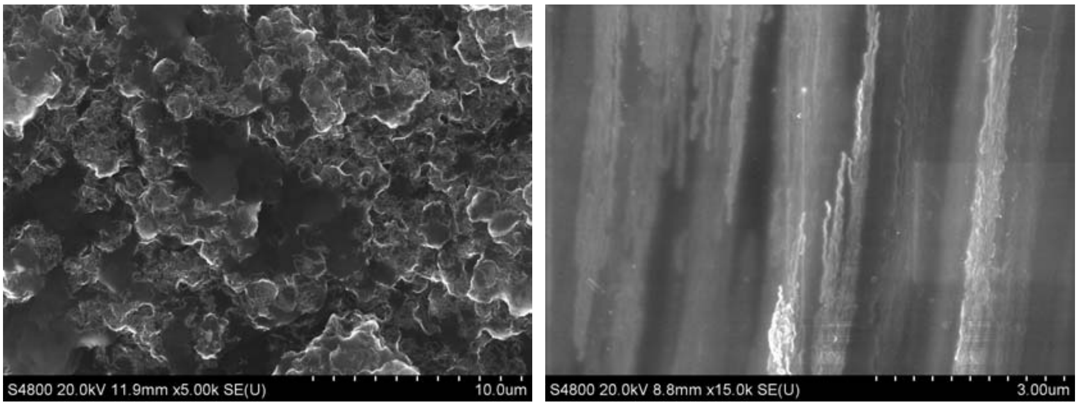

Figure 2: SEM pictures form a 5% CNT composite. Left: Composite in powder form; right: Alignment of MWCNT along the fiber axial direction.