CARBON NANOTUBE BASED NANOCOMPOSITE SENSORS

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Polymer nanocomposites, PNCs, have emerged as a new class of materials in the past decades and attracted considerable interest and investment in research and development worldwide. This is largely due to their new and often much improved mechanical, thermal, electrical and optical properties as compared to the conventional filled polymer or polymer blends.

One of the most promising nanofillers to dope polymers are the Carbon Nanotubes, CNTs; their structural and electrical characteristics make them promising for developing unique and revolutionary smart composite materials. Several smart material properties like piezoresistance and electrochemical effect have been reported. Furthermore, CNT based sensors possess a number of advantages including extreme sensitivity, good selectivity and fast response.

INASMET-Tecnalia is working on new functionalities based on the sensing properties of CNTs; the non-destructive monitoring of damage within polymer based composite structures and the capabilities of gas sensing when exposing to VOCs are two specific examples.

For the first application, the control of the electrical resistance in composite laminates is being studied as the property that could alert in possible failure or mechanical damage of critical structural parts in planes, building constructions, bridges, etc.. Although smart sensors like piezoelectric elements, optic fibres or shape memory alloys are being developed and applied for monitoring the damage tolerance of composite structural components, these systems are frequently expensive and complex, even the system can generate sometimes a possible failure point. So a new idea where the own structure has self-sensing capability without additional sensors is being investigated.

For the second application, the electrical resistivity of the nanocomposites is being studied upon exposure to vapor atmospheres. Conventional gas sensors usually operate at high temperatures but chemiresistor sensors based on carbon nanotubes display high sensitivities and fast response time even at room temperature. Besides, carbon nanotube sensors are more stable than metal oxide sensor since they are not affected by chemical changes on the surface. Finally, the robustness of the sensor is ensured when protected by polymer.

In both applications, several nanocomposites have been fabricated incorporating different types of CNTs into several polymeric matrices; the challenge has been to obtain a good dispersion of them inside the matrix and a perfect interface between both. Different concentrations of nanotubes have been studied to know the percolation threshold. The influence of the functionalization on the conductivity values of the nanocomposites has been also studied. Finally, the manufactured nanocomposites have been exposed to several strains or solvents in order to evaluate the electrical response and to understand the sensing mechanism.

References:

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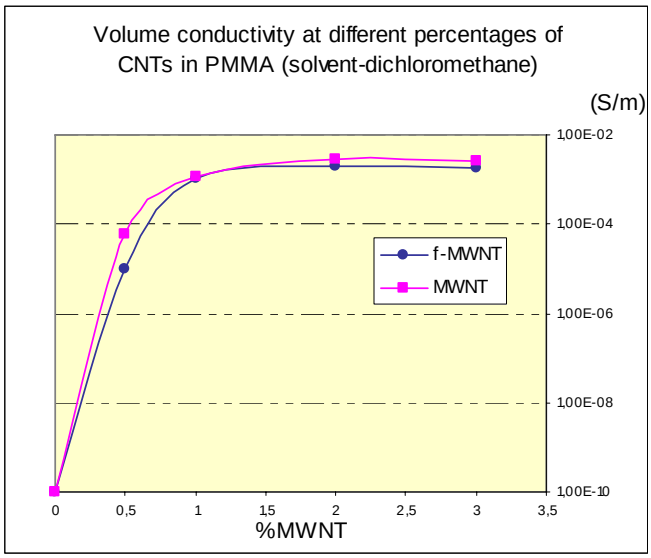
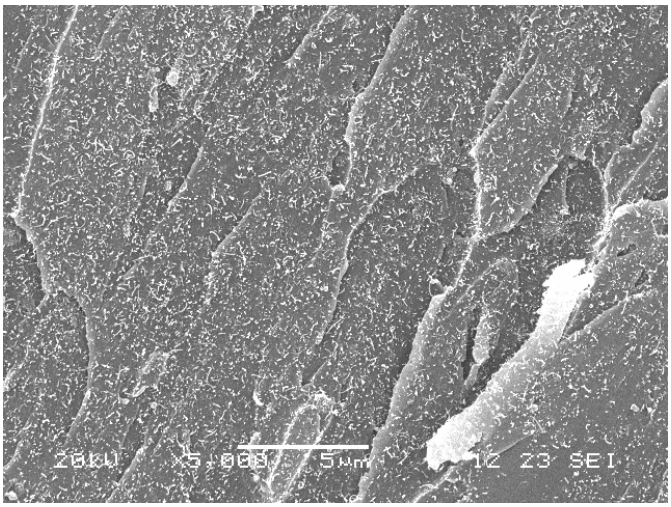
Figures:





SEM micrograph of 1% functionalized MWNTs in epoxy