Effect of MWNT on Pan Thermal Stabilization

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Addition of carbon nanotubes to polyacrylonitrile (PAN) precursors is known to improve the mechanical properties of carbon fibers resulting from PAN thermal treatment. Interaction of PAN with single wall carbon nanotubes (SWNT) and effect of the latter on mechanism of PAN thermal stabilization and its product's properties have been widely studied. On the other hand, multi wall carbon nanotubes (MWNT) are cheaper and easier to be produced than SWNT, but little information is available on details of thermally induced stabilization of PAN/MWNT nanocomposites.

The aim of this work was to do a comparative analysis of structure and properties of PAN/MWNT composite and pure PAN films and to investigate the role of MWNT as a reinforcing phase which can trigger stabilization of PAN.

PAN/MWNT composite and pure PAN films were prepared under the same conditions by solvent cast technique from dimethyl sulphoxide solutions. To investigate the effect of MWNT addition on structure, thermal properties and stabilization process wide-angle X-ray diffraction and scanning electron microscopy studies, simultaneous thermogravimetric analysis and infrared spectroscopy were employed.

It was found out that addition of MWNT significantly changes the structure of composites. These changes result in decrease of stabilization temperature and integral calorific effect of stabilization process. Structure of PAN/MWNT nanocomposites leads to less local overheating during thermal stabilization process, therefore higher product yield and more perfect product structure.

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FTIR studies have revealed that under the same conditions of thermal processing pure PAN and MWNT-containing material result in different stabilization products. As compared to pure PAN case, the nanocomposite stabilization product reveals less of noncyclic moieties. Thus, addition of MWNT to PAN is proved to increase conversion of the stabilization reactions, leading to more perfect structure of the product. Moreover, spectral studies of the intermediate materials during the linear heating demonstrated that in case of PAN set of reactions run at the same temperature range (simultaneously), whereas during thermal stabilization of PAN/MWNT gradual increase of temperature induces at first preferably cyclization reactions, and dehydration along with nitrile elimnation from acyclic fragments occur at higher temperatures.

By tuning the processing conditions one can influence the structure of final PAN/MWNT nanocomposite and its behavior during stabilization. It was revealed that MWNT addition technique resulting in filler distribution and processing conditions (including composition and temperature of coagulation bath) play a crucial role. Properties of control composite samples made by simply adding MWNT to PAN solution are similar to pure PAN material.

In other words it was found out that MWNT significantly effect on matrix structure resulting in unique thermal properties of MWNT/matrix composites.