Synopsis

Thermoplastic-based composites are becoming more important in many application fields for the possibility of combination of toughness of thermoplastic polymers with stiffness and strength of reinforcing fibers. The ultimate properties of the composites solely depend on the characteristics features of fiber and matrix and on the adhesion strength at the interface. In order to massive and economical application matrix should be easily available, economic and well established. For that purpose ethylene polypropylene copolymer, syndiotactic polystyrene and polycarbonate have been chosen as the base matrix for the reinforced composites. Organic textile fibers can be used to prepare polymer composite. Due to their low stiffness organic textile fibers are used as reinforcing agent in polymer matrices, such as rubbers and thermoplastics. It is well known that behavior of the polymeric material strongly dependent on its structure, morphology and relaxation processes. Furthermore, the properties of composite materials are determined by the characteristics of the polymer matrices themselves, together with reinforcements, and the adhesion of fiber/matrix interface, which mainly depends on the voids and the bonding strength at the interface. A particularly effective approach to surface modification is direct fluorination, as this process does not need any initiation proceeding at practically acceptable rates at ambient temperatures for exothermic nature of this reaction. Besides fluorinated polymers are known to have a set of unique properties, including enhanced mechanical stability and thermaostabilty and good barrier and membrane properties, which are mainly defined by their surface properties. Here we have focused on the preparation of composites from Kevlar fiber, modified by direct fluorination and oxy-fluorination and various thermoplastics such as Ethylene propylene copolymer, syndiotactic polystyrene, and polycarbonate. The effects of such modified Kevlar fiber on the various properties of the aforementioned composites have been studied here. The simulation of fiber orientation in the s-PS matrix has also been studied using mold flow technique under various injection processing conditions.

Firstly thermomechanical behavior of fluorinated and oxy-fluorinated Kevlar fiber-reinforced ethylene propylene (EP) composites has been studied. The composites have been prepared using brabender mixer and are cured using compression molding technique. FTIR study has been performed to understand the chemical reaction occurred due to modification of composites. Thermal behavior and crystallinity of the composites have been studied by DSC, TGA, DMTA and XRD. These studies show that thermal stability, storage modulus, as well as crystallinity of the treated Kevlar fiber-reinforced EP increases in comparison to the untreated derivative because the surface modified Kevlar fiber results in good adhesion between the fiber surface and EP matrix. Tensile strength increases in case of treated Kevlar fiber-reinforced EP in comparison to the untreated one. SEM study supports all the above results. AFM results show that surface roughness increases because of the surface modification resulting from the incorporation of functional group-induced Kevlar fiber.

A comprehensive study on the effect of compatibilizers on the thermal, dynamic mechanical, crystalline and rheological properties of unmodified fluorinated and oxy-fluorinated short Kevlar fiber reinforced ethylene propylene copolymer (EP) has also been carried out under this research work. The compatibilizers used in this study are maleic anhydride grafted Polypropylene (MA-g-PP). The composites were prepared in brabender mixer and were molded in compression molding. The compatibilized samples show improved thermal, dynamic mechanical crystalline as well as rheological properties as a result of better adhesion between the fiber and matrix at the interface. The compatibilizing effect is much more pronounced in case of oxy-fluorinated Kevlar /EP composites in comparison to the untreated and fluorinated Kevlar/EP composites.

The effects of surface modified Kevlar fibers, fiber loading and the resultant crystalline, thermal, dynamic mechanical and morphological properties of Kevlar fiber and thermoplastic ethylene- propylene polymer composites have also been discussed here. Incorporation of surface modified Kevlar fibers enhances the crystallization of the matrix through heterogeneous nucleation compared to unmodified Kevlar fiber. Modified Kevlar fiber reinforcement significantly improved thermal stability of the composites as evidenced by thermo gravimetric analysis. Dynamic mechanical analysis shows that an increase in the storage modulus is more pronounced in case of surface modified Kevlar fibers. The physico-chemical properties also improved with high fiber content in the composites.

Again the effects of the surface modified Kevlar fiber on the crystalline, thermal, dynamic mechanical properties of the Kevlar fiber reinforced syndoitactic polystyrene (s-PS) composites have been explored overhere. The crystallization temperature shifts to a higher value in case of unmodified and fluorinated Kevlar fiber reinforced composites in comparison to the oxy-fluorinated one. Kevlar fibers enhance the crystallization of the matrix through heterogeneous nucleation. Modified Kevlar fiber reinforcement significantly improved the thermal stability of the composites as evidenced by the Thermogrvametric analysis (TGA). Dynamic Mechanical Analysis and Differential Scanning Calorimetry show the shift of T_g to slightly higher value in case of modified Kevlar fiber reinforced s-PS in comparison to the unmodified derivative. This is because of the more fiber/matrix interaction in case of modified Kevlar fiber/s-PS. Dynamic mechanical analysis shows that an increase in the storage modulus is more pronounced in case of surface modified Kevlar fibers.

Fluorinated and oxy-fluorinated Kevlar fiber was again blended with SPS at 300^0C under 10 rpm in a twin-screw extruder. The composites were then injection molded into dumbbell shaped specimens under different conditions like various mold temperatures, injection temperatures, injection speeds. Various physico-chemical characterizations of the composites have been done and effect of all the processing parameters and the chemical modifications were studied. It has been found out that the processibility differ widely with the variation of processing parameters during injection molding. The orientations are different in the skin and core region, which once again affects the flow behavior. The bulk technical properties were found to be the function of the fiber orientations in skin and the core of the injection molded samples. Scanning electron microscopy reveals the better fiber/matrix adhesion in case of modified fiber reinforced syndiotactic polystyrene composites.

Lastly the effect of fluorination and oxy-fluorination of Kevlar fiber on the thermal, dynamic mechanical, crystalline and morphological properties and the simulation of the fiber orientation using mold flow simulation technique under different injection molding parameters of the PC/ LCP/ Kevlar composites have been explored. LCP has enhanced the thermal stability of the PC matrix. Incorporation of modified and unmodified Kevlar fiber further enhances the thermal stability of the concerned composites as evidenced from TGA. XRD study reveals the induction of crystalline behavior of the PC matrix due to the incorporation of the LCP and which is further augmented by the incorporation of the unmodified as well as modified Kevlar fiber. DMA results in the improvement of the storage modulus of the PC matrix in presence of LCP. Incorporation of unmodified and fluorinated and oxy-fluorinated

Kevlar fiber into the PC/LCP system further enhances the magnitude of storage modulus and this trend is much more pronounced in case of oxy-fluorinated derivative. T_g of the PC phase shifted to the lower temperature side in presence of LCP and it further shifted towards lower temperature side with incorporation of unmodified Kevlar fiber. Incorporation of surface modified Kevlar fiber into the PC/LCP system shifted the glass transition temperature towards higher temperature side as evidenced from DSC and loss peak of the composites. SEM reveals the fine fibrillation of LCP phase in the PC matrix phase in case of oxy-fluorinated Kevlar fiber reinforced derivative indicating the best fiber/matrix adhesion at the interface, although the fibers are covered by the matrix. Mold flow simulation technique reveals that the fiber orientations are different in the skin and core region, which affects the flow behavior. The bulk technical properties were found to be the function of the fiber orientations in skin and the core of the injection molded samples.

Key words: Direct fluorination, Direct oxy-fluorination, Ethylene propylene copolymer, Maleic anhydride grafted polypropylene, Syndiotactic polystyrene, Polycarbonate, Liquid Crystalline Polymers, Thermal stability, Crystallinity, Dynamic Mechanical Properties, Fiber orientation, Adhesion, Mold flow simulation technique.