CHAPTER 5

CONCLUSIONS

The addition of nano-size fillers interfere with the polymer structure, results in enhancing mechanical properties of composite materials. This new type of high quality and innovative material promotes development of new generation high performance materials. In this study silica nano particles were successfully incorporated in three different types of polymers matrix, i.e. polyamide, polypropylene and polyester.

In the first part of work, polyamide/ silica nanocomposite film was successfully produced by a simple dissolution technique under atmospheric condition. The uniform distribution of silica nanoparticles were observed under SEM and the chemical composition of composite structure were confirmed by FTIR spectroscopy. The SEM micrographs show uniform distribution of silica nanoparticles throughout the surface of film up to 0.7 % concentration, but at 1% concentration the composite film was tendered. The d-spacing value was increased which is due to the increased strain on account of increased surface to volume ratio in nano particles of silica. It was also found that the lesser the quantity of silica particle in dissolution mixture, higher is the enthalpy (ΔH) value of composite film.

The composite film exhibits an increased tensile strength with an increase in silica content. However, composite films contain 1.0 % by wt. silica in mixing exhibited erroneous trend of tensile properties due to poor particle distribution. The young's modulus of polyamide composite film was also found increased with the increase in concentration of nano silica particles up to 0.7% concentration but it reduced at 1% concentration. Similarly, the work of rupture was also showing the increasing trend due to addition of silica nano particles. The improvement in work of rupture was 606.55% at 0.7% concentration compare to the pure polyamide film. Polyamide silica nanocomposite film with 0.7% concentration of silica nano particles can successfully be utilized for manufacturing of packing materials.

Polypropylene chips and silica nano particles were mixed in twin screw extruder and chips were prepared. Pure polypropylene filament and polypropylene-silica nanocomposite filaments were successfully spun on melt spinning pilot machine, the results has been discussed in second part of the study. The presence of silica nano in the prepared composite filament were observed by SEM and elementally confirmed by EDX. The chemical composition of the composite was further confirmed by FTIR spectroscopy. The structure of the prepared composite filament was analyzed by X-ray diffraction technique, which indicates that the structure of the prepared composite filament was crystalline compared to the highly amorphous structure of polypropylene filament prepared without the addition of silica nano. The addition of silica in the polypropylene filament further increases the enthalpy (ΔH) required to melt filament but there was no effect on melting temperature due to loading of nano silica to the polypropylene filament.

The mechanical properties of the filaments were found improved upto 0.7% addition of nanoparticles. Almost 67.80% higher tenacity was found in composite filament with 0.7% loading of nano silica compared to the pure polypropylene filament. The young's modulus of polypropylene filament was also found increased with the increase in concentration of silica nano particles i.e. up to 0.7% concentration. The increase in young's modulus was highest at 0.7% concentration which is 73.33% higher than pure polypropylene filament. The highest work of rupture was also observed at 0.7% concentration, however no specific trend for the same was observed.

The nano silica particles were successfully applied on polyester fabric using pad-dry-cure technique. The presence of silica on the fabric surface was observed in SEM micrographs further confirmed by the FTIR spectrum and XRD pattern. SEM micrographs indicates that the silica nano particles are of 100 nm diameter and spherical in shape, distributed uniformly on the surface of individual fibres of fabric. The chemical composition of treated fabric was confirmed by FTIR spectra. Further the structure of fabric was found semi crystalline in nature as per X-ray diffraction analysis. The enthalpy (ΔH) required to melt the polyester silica nanocomposite fabric has increased as compare to pure polyester fabric by 5.46%. The nano silica coating of PET fabric was done by padding technique, which could be the probable reason for less interaction between nano particles and PET polymer, which is also reflected by lesser changes in mechanical properties, however in FTIR analysis minor Si-O-Si peak was observed. This may also reflect in melting point which remains almost unchanged for coated as well as pure polyester fabric.

The treatment enhances the mechanical properties such as tensile strength, tearing strength and crease recovery angle of treated polyester fabric compared to the untreated counter part of the same. It also improves with increase in the concentration of silica nano up to 5 gpl. The treatment with silica nano particles increases the tensile stress in warp as well as weft directions of polyester fabric. Addition of nano silica particles does not change the young's modulus significantly. The loading of nano particles was found enhancing the work of rupture property of polyester fabric in both the direction. The tearing strength of silica treated fabric was found improved by 1 to 2 % with 1gpl to 5gpl addition of silica nano compare to the untreated polyester fabric. Similar results were recorded for crease recovery angle of the fabric shows minor improvement in both warps and weft way of the silica treated polyester fabric. This indicate that the incorporation of nano silica particle improve the mechanical properties of the fabric without imparting rigidity to the fabric.

The incorporation of nanometre-sized inorganic silica particles can improve the mechanical properties as well as thermal stability of polymer, which can be utilized as high performance technical textiles.

At last Nanotechnology holds an enormous, promising future for textile. The development in functional properties is endless with nano technology and at present, the application of nanotechnology in textile has merely reached the straight line. The new concept explored the nano material application area in textiles for further research and development.

SCOPE FOR FURTHER STUDY

These results encourage further investigation on incorporation of different nanoparticles in different forms of polymers i.e. film, filament and fabric during their preparation stage. The durability and compatibility of nanoparticles with the respective polymers can be analyzed by other advanced techniques i.e. TEM, to evaluate their effect on desired functional properties through the changes in polymer matrix, promoting the interest on potential applications of such nanocomposite materials in technical textile field.

This study can further be extended by comparing the properties of developed product with commercially available products.