UGC Minor Project (1728-.MRP/12th Plan/14-15/KLKE052/UGC-SWRO dated 29/10/2015)

DEVELOPMENT OF CONDUCTING POLYMER BLEND COMPLEX FILMS FOR OPTOELECTRONIC DEVICE APPLICATIONS

SUMMARY OF FINDINGS

Organic semiconductor materials have aroused considerable interest among researchers because of their unique properties like conductivity, light emission, anti-corrosive nature, memory applications etc. Organic semiconductors possess high mechanical flexibility, versatility of the chemical structure and low fabrication cost. They have emerged as potential candidates in the optoelectronic field competing with the silicon based inorganic counterparts. It could be suggested that the conducting plastics points to enormous possibilities for future studies in the field of energy storage, in microelectronics, as electrical fuses, switches, sensors, conducting textiles, electrode materials and solid state electrolyte in batteries. With their proven advantages of plastic flexibility, these materials have versatile promising applications in EMI shielding, in radar-absorbing materials (RAMs) and in anti-static clothing.

Polymer blending technique is used to develop of new polymeric materials, which combines the excellent properties of the blended raw materials. Blending of polymers consumes less time and is cheaper than to development new monomers from new polymeric materials. Thermoplastic elastomers are easy to process with relatively short processing time, and have potential for recycling.

The nylon 6 and natural rubber selected for study have wide use in our day-to-day life as good insulators, packaging materials, raw materials for industry and many such daily applications. Kerala is one of the largest producer of natural rubber in the country and is a household item of rural areas. Nylon 6 is an important commercial thermoplastic with good mechanical properties. Natural rubber is an elastomer, which exhibits good impact factor, high elongation and high resilience even at low temperature. Blending nylon 6 with natural rubber could result in a homogeneous blend of the two components. The blend would possess interesting properties of two blended polymers.

The present study attempts to infuse the major scientific innovation of recent times i.e. development of intrinsic electrical conductivity in the blend of two familiar and common household materials abundantly available in our easy reach. It would be interesting to see that

these common materials could be made conducting or semiconducting. This is the major motivation to select these polymers for this study. They are easily soluble in many organic solvents compared to conjugated polymers. Their ability to form thin films from solution allows them to be deposited on different substrates of desired shapes. This property provides them with opportunities for many electronic applications. The cost factor and easy processability makes them more attractive than conventional electronic devices.

Homogeneous blends of nylon 6 LNR were prepared using solution casting method with HTAB as surfactant. Semiconducting films of the blend was prepared by iodine sorption in hexane solution. The maximum dc conductivity was found to be 3.2×10^{-3} S cm^{-1} for films, which contained 200 wt. percentage iodine. The conductivity increased with the iodine content in the film. The UV visible absorption studies reveals the formation of homogeneous thermoplastic elastomeric blend with intermediate properties of individual polymers. For the doped complex films, the absorption band has extended to the visible and near infrared region confirming the formation of CTCs. The optical bandgap of the polymer blend showed a value in-between that of the pristine polymers. The iodine doped films showed a discernible shift towards lower energies. The refractive index of the blend films were found using reflection spectra. The refractive index of blend films was found to be higher than that of pristine nylon 6 and natural rubber. While the extinction coefficient of the blend films possessed intermediary value of the individual polymers, the electric susceptibility of blend film was much higher than pristine films, illuminating the fact that polymer blend film was more polarizable than pristine films. Relative permittivity value was also higher for the blend. FTIR spectra and XRD studies also suggested the formation of homogeneous blend with more amorphous nature. The melting and crystallization peaks of blend film showed a shift towards lower values. SEM photographs also showed a formation of homogenous blend of nylon 6 and natural rubber.

Based on the conclusions arrived the study leads to further studies in the field in the field of in microelectronics, as electrical fuses, switches, sensors, electrode materials and solid state electrolyte in batteries. More information on the material could be obtained by using techniques like Atomic Force Microscopy, Raman Spectroscopy, and Nuclear Magnetic Resonance can contribute the application potential of these materials to new heights. New techniques like Laser Ablation may be used for the preparation of thin films.

CONTRIBUTION TO THE SOCIETY

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PUBLICATIONS FROM THE WORK

- A paper entitled **"Electrical and Optical Properties of Semiconducting Nylon 6 Films"** was presented in the National conference on light 'Optics-2017' from 9-11 Jan., 2017 at NIT Calicut.
- A paper entitled **"Optical Characterization of Polymer Blend Films for Optoelectronic Device Applications"** was accepted in the International Conference on Recent Trends in Materials Science and Technology, organised by Indian Institute of Space Science and Technology, Thiruvananthapuram and Material Research Society of India, Thiruvananthapuram from October 10-13, 2018 at ATF Area, VSSC, Thiruvananthapuram.

optics'17

A conference on Light

9-11 January 2017
National Institute of Technology Calicut, Kerala, India

Certificate

This is to certify that Mr/Ms/Dr. K. Sreelatha

has ~~participated~~ / presented ~~the paper entitled~~

an invited talk on " Electrical and optical Properties of semiconducting Nylon-6 films" *in the conference.*

Dr. P. Predeep
(Convener)

Dr. A. Sujith
(Convener)

Organized by
Indian Institute of Space Science and Technology
Thiruvananthapuram

ICMST 2018

Jointly with
Materials Research Society of India
Thiruvananthapuram Chapter

International Conference on

Recent Trends in Materials Science and Technology

October 10 - 13, 2018

Certificate

This is to certify that Dr./Mr./Ms. Sreelatha K., SN College, Chengannur has participated in the International Conference on Recent Trends in Materials Science and Technology (ICMST-2018) jointly organized by Indian Institute of Space Science and Technology, Thiruvananthapuram and Materials Research Society of India, Thiruvananthapuram Chapter, held during October 10-13, 2018 at Thiruvananthapuram. He/She presented a paper entitled "Optical Characterization of Polymer Blend films for Optoelectronic Device Applications"

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