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Synthesis and Characterization of Optical Polymer Polyacrylonitrile Nanomaterial

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Abstract:-Polyacrylonitrile (PAN) is a synethic semicrystalline resin. PAN nanofibers were electrospun from PAN-based answer for the preparation of carbon nanofibers.The polyyacrylonitrile was hot-stretched by electrospinning method at a very high voltage under temperature controlled oven. Optical microscopy and Scanning electron microscopy (SEM) were utilized to describe the morphology of the nanofibers, which showed that carbon nanofibers were scattered well in the composites and were totally wrapped by PAN matrix. PAN application performance will enhance the mechanical properties and the electrical properties.

Keywords:-Polyacrylonitrile, Electrospun, Scanning Electron Microscopy (Sem), Optical Microscopy.

I. INTRODUCTION

Polymer composites have steadily gained growing importance during the past decade. Optical properties constitute one of the convenient and sensitive studying the polymer structure. They are affected not only by the structure and nature of the dopant but also by the doping procedure. Polymers are substances containing a large number of structural units joined by the same type of linkage. These substances often form into a chain-like structure. Polymers extend from commonplace engineered plastics, for example, polystyrene to regular biopolymers, for example, DNA and proteins that are key to organic structure and capacity Polymers, both natural and synthetic, are created via polymerization of many small molecules, known as monomers. Polyacrylonitrile (PAN), otherwise called Creslan 61, is a manufactured, semicrystalline natural polymer pitch, with the direct recipe (C3H3N)n. Though it is thermoplastic, it does not melt under normal conditions. It degrades before melting. It melts above 300 °C if the heating rates are 50 degrees per minute or above.Electro-spinning is a most ideal method for creating strands in nano and smaller scale measure scale. A polymer arrangement is encouraged through a syringe with a metal needle. A high voltage is associated between the needle and a grounded authority, making an electric field in which the fiber is tremendously extended upon its approach to gatherer. The extending together with vanishing of the dissolvable renders strands in nano to small scale size to be gathered on the collecter. Applications of the nanofibers are sound retention, channels, sensors and biomedicine.

II. EXPERIMENTAL

A sol is a scattering of the strong particles (~ 0.1-1 μm) in a fluid where just the Brownian movements suspend the particles. A gel is a state where both liquid and solid are dispersed in each other, which presents a solid network containing liquid components. The sol-gel covering process more often comprises of 4 stages: (1) The desired colloidal particles once scattered in a fluid to frame a sol. (2) The deposition of sol arrangement creates the coatings on the substrates by showering, plunging or turning. (3) The particles in sol are polymerized through the expulsion of the balancing out segments and create a gel in a condition of a consistent system. (4) The last warmth treatments pyrolyze the staying natural or inorganic segments and shape a nebulous or crystalline covering.

Electro-turning is a most ideal method for creating filaments in nano and smaller scale measure scale. A polymer arrangement is sustained through a syringe with a metal needle. A high voltage is connected between the needle and a grounded collector, creating an electric field in which the fiber is immensely stretched upon its way to collector. The extending together with evaporation of the dissolvable renders filaments in nano to small scale size to be gathered on the gatherer. Uses of the nanofibers are sound retention, channels, sensors and biomedicine.

It consists of three major components: a high voltage power supply, a spinneret (a metallic needle), and a collector (a grounded collector). The spinneret is connected to a syringe in which the polymer solution (or melt) is hosted. With the use of a syringe pump, the solution can be fed through the spinneret at a constant and controllable rate. When a high voltage (usually in the range of 1 to 30 kV) is applied, the pendent drop of polymer solution at the nozzle of the spinneret will become highly electrified and the induced charges are evenly distributed over the surface. As a result, the drop will experience two major types of electrostatic forces: the electrostatic repulsion between the surface charges; the coulombic forces exerted by the external electric field. Under the action of these electrostatic interactions, the liquid drop will be distorted into a conical object commonly known as Taylor cone. Once the strength of the electric field has surpassed a threshold value, the electrostatic force can overcome the surface tension of the polymer solution and thus force the ejection of a liquid jet from the nozzle. The electrified jet then undergoes a stretching and whipping process, leading to the formation of a long and thin thread. As the liquid jet is continuously elongated and the solvent is evaporated, itsdiameter can be greatly reduced from hundreds of micrometer to as small as tens of micrometers. Pulled in (inverse charge) by the grounded gatherer set under the spinneret, the charged fiber is regularly kept as a randomly situated, non-woven tangle.

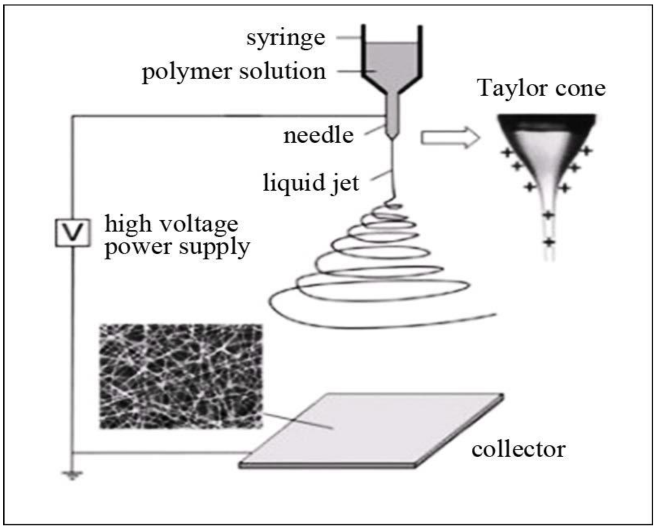

Fig. 1

A. Materials& Formation

Gm of PAN is dissolved in 10ml of DMF (dimethylformamide).This solution is heated in stirring hot plate until a clear solution is obtained and until it becomes semi-fluid as like gel form. By using the e-spin equipment the characterization will be done, firstly the the syringe is filled with the prepared solution. Then the spinneret is connected to a syringe in which the polymer solution (or melt) is hosted. With the use of a syringe pump, the solution can be fed through the spinneret at a constant and controllable rate. When a high voltage (usually in the range of 1 to 30 kV) is applied, the pendent drop of polymer solution at the nozzle of the spinneret will become highly electrified and the induced charges are evenly distributed over the surface. After an hour the equipment is turned and the butter paper is removed to maintain its purity. Optical synthesis is done for these resulted fibers to know its effective optical properties.

III. RESULTS AND DISCUSSION

Morphology and Microstructures of the Electrospun Composites Nanofibers:It can be seen from figure3 that there is no conspicuous conglutination in the nanofibers after the presentation, which demonstrated that nanofibers were moderately scattered well in the composites. Also, Figure 3(c) demonstrated the hot extended PAN nanofibers, archiving the better arrangement along the sheet hub after the hot extended handle. It can further be found that the arrangement of the filaments turned out to be nearer to parallel in the wake of being hot extended. Likewise, the normal distances across of the first as-spun strands were fundamentally decreased from 200nm to 120nm after hot extending.

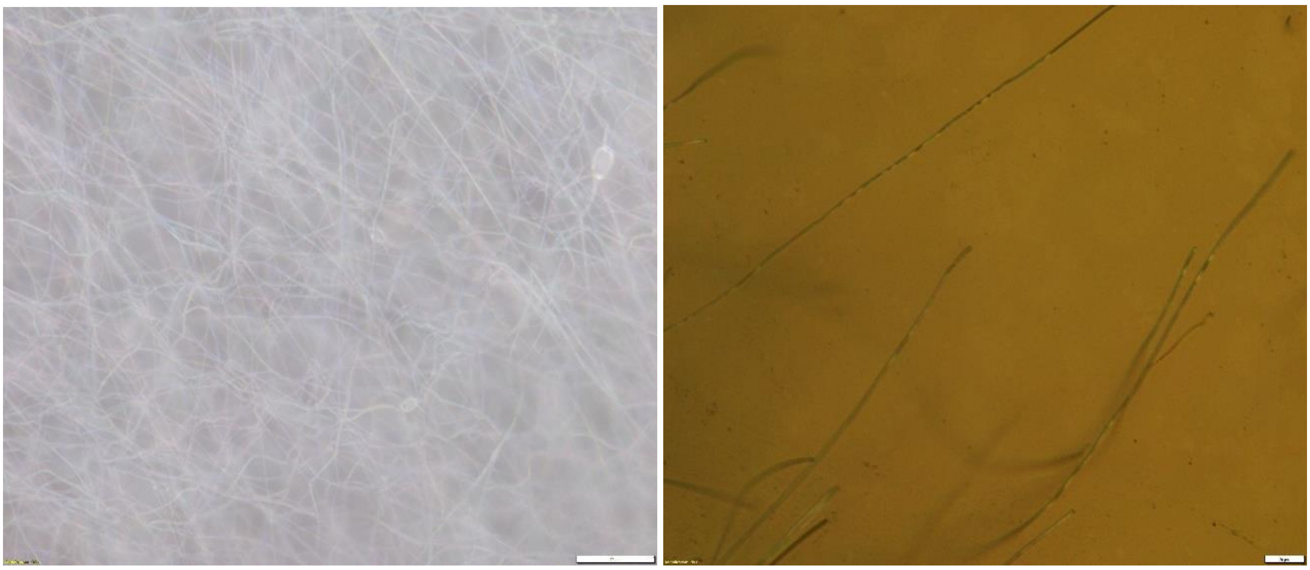

Fig. 2: Optical Micrographs: (A) As-Spun Pure Partially Aligned PAN Nanofibers (B) As-Spun Partially Aligned PAN Nanofibers

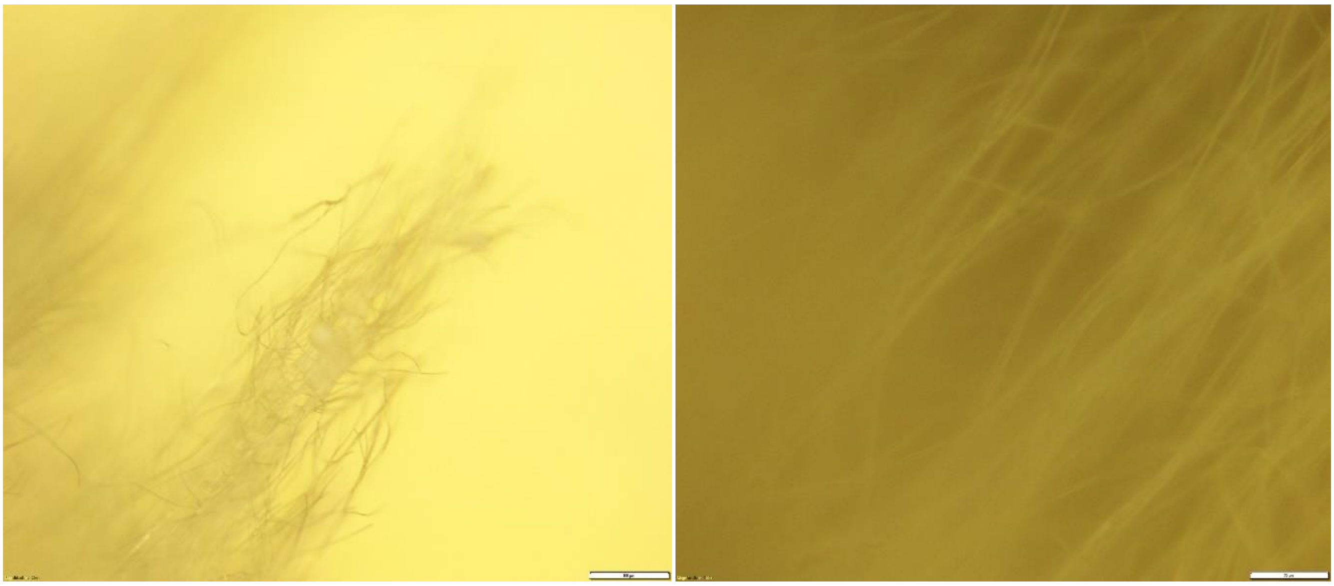

Fig. 3: (C) Hot-Stretched Pure PAN Nan Fibers.

IV. CONCLUSION

In summary, this study showed that 1g/mol polyacrylonitrile-based carbon nanofibers,can be obtained by electrospinning process. The composites exhibited improvements in thermal, mechanical properties,and so forth.The PAN nanofibers better alignments can be achieved by hot-stretched process.The morphology of the nanofibers characterized by Optical Microscopy and SEM showed that carbon nanotubes were completely wrapped by the PAN matrix and oriented well along the fiber axis. The applications of Pan nanofibers are in transmission of data, hot gas filtration systems, outdoor awnings, sails for yachts, and fiber-reinforced concrete.

REFERENCE

[1]. Bo Qiao, Xuejia Ding, Xiaoxiao Hou, and SizhuWu” Study on the Electrospun CNTs/Polyacrylonitrile-Based Nanofiber Composites” Vol 2011, Article ID 839462.
[2]. Yang Chengran, Wang Biao, Zhang Yumei “Synthesis and Characterization of Polyacrylonitrile Copolymers Containing Amine Groups”.
[3]. Lefayet Sultan Lipol, Md. Moshiur Rahman” Electrospinning and Electrospun Nanofibers” World Journal of Nano Science and Engineering, 2016, vol-6, 45-50.
[4]. R. Eslami Farsani, R. Fazaeli, “Applications of Carbon Fibers Produced from Polyacrylonitrile Fibers”, International Journal of Chemical, Molecular, Nuclear, Materials and Metallurgical Engineering Vol-6, No-8, 2012.
[5]. T. V. Semenistaya, “Polyacrylonitrile-Based Materials: Properties, Methods and Applications”pp 61-77, dOI: 10.1007/978-3-319-26324-3_5.
[6]. Zheng-Ming Huang[a], Y.-Z. Zhang[b], M. Kotaki, S. Ramakrishna, ‘A review on polymer nanofibers by electrospinning and their applications in nanocomposites” Volume 63, Issue 15, November 2003, Pages 2223–2253.
[7]. E.J. Ra[a, b], E. Raymundo-Piñero[a], Y.H. Lee[b], F. Béguin “High power supercapacitors using polyacrylonitrile-based carbon nanofiber paper “,Volume 47, Issue 13, November 2009, Pages 2984–2992.
[8]. Joseba Zubia and Jon Arrue, “Plastic Optical Fibers: An Introduction to Their Technological Processes and Applications”, Optical Fiber Technology 7, 101_140 Ž2001.
[9]. Mohd Syuhaimi Ab-Rahman, Hadi Guna, Mohd Hazwan Harun.“1xN Self-Made Polymer Optical Fiber Based Splitter for POF-650nm-LED based Application”, 2009 International Conference on Electrical Engineering and Informatics 5-7 August 2009, Selangor, Malaysia 978-1-4244-4913-2/09/$25.00 ©2009 IEEE EE-03.
[10]. Norhaniza Yusof, , Dipak Rana[c], Ahmad Fauzi Ismail[a], Takeshi Matsuura, “Microstructure of polyacrylonitrile-based activated carbon fibers prepared from solvent-free coagulation process”, Volume 14, Issue 1, February 2016, Pages 54–61.