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ELECTRO SPINNING TECHNIQUE IN ENERGY TRANSMISSION APPLICATION

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Abstract: Electrospunnanofibres have increasingly attracted attention to be used as new generation. Energy transmission application since theyhave the nanofibrous structure. This paper gives the review of researchon electrospun nanofibres for energy application.In this paper it is shown that Fuel cell can be form by electrospinning technology which may use in energy applications. The energy engineering strategy is to facilitate the growth of renewable energy application, Electrospinning can generate fibrous meshes having fibre diameter dimensions at the nanoscale and these fibres can be nonwoven.The nano fibre have been used for fuel cell and solar cell.

Keywords: -Nanotechnology, Fuel cell, Solar Energy.

I. INTRODUCTION

The application of nanotechnologies to energy transmission has the potential tosignificantly impact both the deployed transmission technologies and the need for additionaldevelopment. This could be a factor inassessing environmental impacts of right-of-way (ROW)development and use. For example, some nanotechnology applications may produce materials(e.g., cables) that are much stronger per unit volume than existing materials, enabling reducedfootprints for construction and maintenance of electricity transmission lines. Other applications,such as more efficient lighting, lighter-weight materials for vehicle construction, and smallerbatteries having greater storage capacities may reduce the need for long-distance transport ofenergy, and possibly reduce the need for extensive future ROW development and many attendantenvironmental impacts.This report introduces the field of nanotechnology, describes some of the ways in whichprocesses and products developed with or incorporating nanomaterials differ from traditional processes and products, and identifies some examples of how nanotechnology may be used toreduce potential ROW impacts. Potential environmental, safety, and healthimpacts are alsodiscussed.

II.ELECTROSPINNINGTECHNOLOGY

In the electrospinning process, an electrostatic force is applied to a polymeric solution to produce nanofibre with diameter ranging from 50 nm to 100 nm or greater .Due to surface tension the solution is held at the tip of syringe. Polymer solution is charged due to applied electric force. In the polymer solution, a force is induced due to mutual charge repulsion that is directly opposite to the surface tension of the polymer solution. Further increase in the electrical potential leads to the elongation of the hemispherical surface of the solution at the tip of the syringe to form a conical shape known as Taylor cone.The electric potential is increased to overcome the surface tension forces to cause the formation of a jet, ejects from the tip of the Taylor cone. Due to elongation and solvent evaporation, charged jet instable and gradually thins in air primarily.The charged jet forms randomly oriented nanofibres that can be collected on a stationary or rotating..

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III. ELECTROSPINNING SETUP

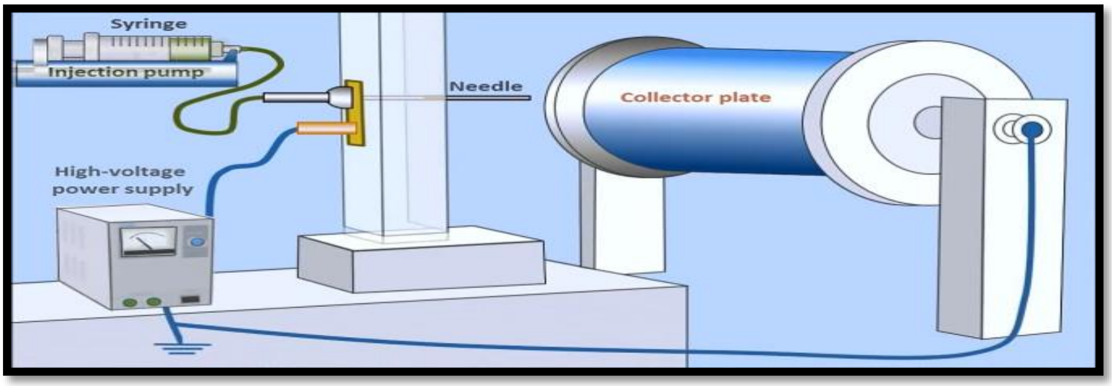

Fig. 1 Elecrto Spining Set Up

A] Basic Component:

a. Syringe pump
b. Syringe
c. Needle
d. Collector plate
e. High voltage DC power supply

IV. WORKINGPRINCIPLE

In electrospining process, high voltage is used to create an electrically charged stream of polymer solution. One end of High voltage electrode is linked with the needle and other end to ground plate collector.Solution is filled in syringe pump. Syringe pump is hydraulically operated. Solution is spray with high pressure with help of syringe pump through needle by setting flow rate and time in syringe pump. Electrostatic force is created between solution coming out from needle and ground plate collector. Taylor cone is formed at the tip of needle producing fibers in micron. Fiber solidifies as the polymer solvent evaporates and creates fiber particles on the surface of collector.

Electro spinning process can be explained in 5 steps, such as:

1) Charging of polymer fluid:

The syringe is filled with an polymer solution, the polymer solution is charged with a very high potential around i.e. 10-30kV. The nature of the fluid and polarity of the applied potential free electrons, ions or ion-pairs are generated as the charge carriers form an electrical double layer. This charging induction is suitable for conducting fluid, but for non-conducting fluid charge directly injected into the fluid by the application of electrostatic field. The syringe is filled with an polymer solution, the polymer solution is charged with a very high potential around i.e. 10-30kV. The nature of the fluid and polarity of the applied potential free electrons, ions or ion-pairs are generated as the charge carriers form an electrical double layer. This charging induction is suitable for fluid, but for non-conducting fluid charge directly injected into the fluid by the application of electrostatic field.

2)Formation of cone jet (Taylor Cone):

The polarity of the fluid depends upon the voltage generator. The repulsion between the similar charges at the free electrical double layer works against the surface tension and fluid elasticity in the polymer solution to deform the droplet into a conical shaped structure i.e. known as Taylor-cone. Beyond a critical charge density Taylor-cone becomes unstable and a jet of fluid is ejected from the tip of the cone.

3) Thinning ofjet in the presence of electric field:

The jet travels a path to the ground; this fluid jet forms a slender continuous liquid filament. The charged fluid is accelerated in the presence of electrical field. This region of fluid is generally linear and thin.

4)Instability of the jet:

Fluid elements accelerated under electric field and thus stretched and succumbed to one or more fluid instabilities which distort as they grow following many spiral and distort path before collected on the collector electrode. This region of instability is also known as whipping region.

5)Collection of the jet:

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Charged electro spun fibers travel downfield until it impact with a lower potential collector drum. Orientation of the collector affects the alignment of the fibers.

V. ELECTROSPINNING TECHNIQUE IS AFFECTED BY DIFFERENT PARAMETERS

A Polymer solution parameters:

1) Molecular weight and solution viscosity

Higher the molecular weight of the polymer, increases molecular entanglement in the solution, hence there is increase in viscosity. The electro spun jet eject with high viscosity during it is stretched to collector electrode leading to formation of continuous fiber with higher diameter but very high viscosity makes difficult to pump the solution and also lead to the drying of the solution at the needle tip. As very low viscosity lead to bead formation in the resultant electro spun fiber, so the molecular weight and viscosity should be acceptable to form nanofibre.

2) Surface tension:

Lower viscosity leads to decrease in surface tension resulting bead formation along the fiber length because the surface area is decreased, but at higher viscosity effect of surface tension is nullified because of the uniform distribution of the polymer solution over the entangled polymer molecules. So, lower surface tension is required to obtain smooth fiber and lower surface tension can be achieved by adding of surfactants in polymer solution.

3) Solution conductivity:

Higher conductivity of the solution followed higher charge distribution on the electrospinning jet which leads to increase in stretching of the solution during fiber formation. Increased conductivity of the polymer solution lowers the critical voltage for the electro spinning. Increased charge leads to the higher bending instability leading to the higher deposition area of the fiber being formed, as a result jet path is increased and finer fiber is formed.

4) Dielectric effect of solvent:

Higher the dielectric property of the solution lesser is the chance of bead formation and smaller is the diameter of electro spun fiber. As the dielectric property is increased, there is increase in the bending instability of the jet and the deposition area of the fiber is increased. As jet path length is increased fine fiber deposit on the collector.

B. Processing condition parameters:

1) Voltage:

Taylor cone stability is depends on applied voltage, at higher voltage greater amount of charge causes the jet to accelerate faster leading to smaller and unstable Taylor cone. Higher voltage lead to greater stretching of the solution due to fiber with small diameter formed. There is greater tendency to bead formation at high voltage because of increased .It is observed that better crystalline in the fiber obtained at higher voltage, because with very high voltage acceleration of fiber increased that reduced flight time and polymer molecules do not have much time to align themselves and fiber with less crystalline formed.

2) Feed rate:

As the feed rate is increased, there is increase in the fiber diameter because greater volume of solution is drawn from the needle tip.

3) Temperature:

At high temperature, viscosity of the solution is decreases and there is increase in higher evaporation rate which allows greater stretching of the solution and a uniform fiber is formed.

4) Effect of collector:

In electro spinning, collector material should be conductive. Collector is grounded to create stable potential difference between needle and collector. a non-conducting material collector reducing the amount of fiber being deposited with lower packing densityPorous collector yields fibers with lower packing density as compared to non-porous collector plate. In porous collector plate the surface area is increased so residual solvent molecules gets evaporated fast as compared to non-porous.

5) Diameter of needle:

Needle with small diameter reduces the clogging effect due to less exposure of solution to the atmosphere and leads to the formation of fibers with smaller diameter. However, very small needle has the disadvantage that it creates problem in extruding droplet of solution from the tip of the needle.

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VI. GENERAL ENERGY APPLICATIONS

Nanotechnology is being used or considered for use in many applications targeted toprovide cleaner, more efficient energy supplies and uses. While many of these applications may not affect energy transmission directly, each has the potential to reduce the need for the electricity, petroleum distillate fuel, or natural gas that would otherwise be moved through energy transmission ROWs. More efficient energy generation and use (and the consequent reduced need to transmit energy over long distances) may decrease the amount of construction, maintenance, repair, and decommissioning activities along the ROWs that would otherwise be neseded to meet increased energy demands. Energy-related technologies in which nanotechnology may play a role include:

• Fuel Cell,
• Heating,
• Transportation,
• Renewable energy,
• Energy storage,
• Lighting,
• Hydrogen generation and storage

- **Application in Fuel cell**

A fuel cell is a device used for electricity generation that is composed of electrodes that convert the energy of a chemical reaction directly into electrical energy, heat, and water. It is similar to a battery, except that it is designed for continuous replenishment of the reactants that become consumed, thereby requiring no recharging. It produces electricity from an external supply of fuel and oxygen, rather than the limited internal energy storage capacity of the battery. Fuel cells come in various sizes and provide useful power in remote locations such as spacecraft and weather stations. Fuel cells are often considered in the context of hydrogen, because they change hydrogen and oxygen into water, producing electricity and heat in the process but no other by-products. A fuel-cell system running on hydrogen has no major moving parts and can be compact and lightweight. Many believe that in the future, fuel cells will be used to power everything from handheld electronic devices to cars, buildings, and utility power plants. IBM projects that fuel cells in cars will be a “daily fact of life” by 2010, and General Motors estimates that it will have a million fuel-cell cars in production by then (IBM 2004). Such technologies may supply much of the power that would otherwise needto be transported viaROWs (although pipelines may still be needed to transport the natural gas or hydrogen that feeds the fuel cells).
Fuel cells are not new, but the materials’ costs and complex manufacturing processes have limited their development. Nanoengineered materials may help improve fuel cells’efficiency in several ways; some examples are highlighted below:

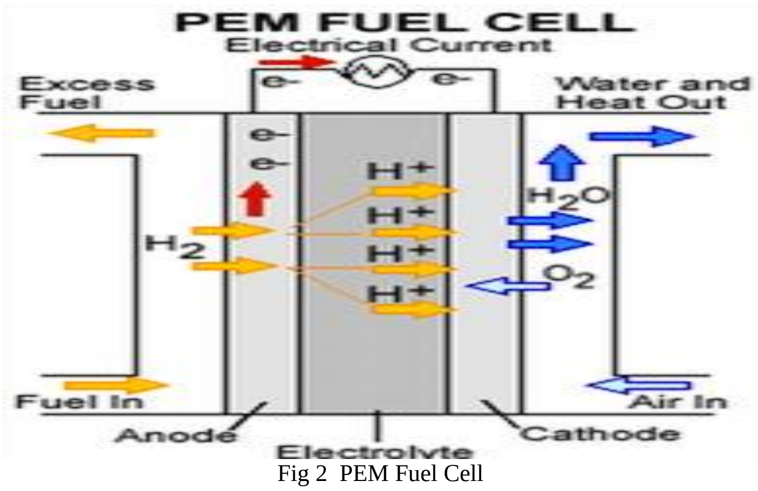

Fig 2 PEM Fuel Cell

• Fuel cells operate by catalyzing the conversion of hydrogen into energy as thehydrogen passes through a catalytic medium. Advanced designs for nextgenerationfuel cells involve the use of a polymer membrane as the structurethrough which the hydrogen passes and on which the catalysis occurs. The useof nanoengineered membrane materials may increase the volume of hydrogenconversion and thus result in more energy (McGahn 2006).

• Precious metal nanoparticles of various compositions have been optimized toact as effective electro-catalysts in polymer electrolyte fuel cells and directmethanol fuel cells at both the anode and the cathode sides (Strem 2006).

• A materials design concept used to control and manipulate the structure of anew material on the nanoscale could lead to more powerful fuel cells thancurrently available and to devices that enable more efficient energy extractionfrom fossil fuels and carbon-neutral fuels. The new electrode material allows more efficient direct utilization of natural gas or biogas (produced from waste) in fuel cells (Ruiz-Morales et al. 2006).

• CNTs' high strength and toughness-to-weight characteristics may beimportant for composite components in fuel cells that are deployed intransport applications where durability is important.

VII. CONCLUSION

In energy field, the electrospun nanofibres have a wide range of applications, from Fuel cell. These applications are made possible due to the characteristics of the nano fibers such as its high porosity and high surface area-to-volume ratio. Although there are other methods of generating nano scale materials, such as drawing, template synthesis, phase separation, self-assembly. Only the electrospinning process has the flexibility and ease of fiber production in both in the lab and in the production plant.

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