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MANUFACTURE OF FIBROUSTRUCTURE FACEMASK TO PROTECT AGAINST CORONAVIRUS USING ELECTROSPINNING

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ABSTRACT

In order to live safely with an exacerbation of the Coronavirus, a face mask must be made with specifications that prevent infection or transmission among people; which is characterized by high efficiency and low cost, and renewable. Fiber structure widely used in air filtration industry using electrospinning method, where its field is booming in an exceptionally impressive manner. Using a biopolymer as a olyhydroxyalkanoates (PHAs) to create a facemask will give excellent results because of the solidity and porosity of the polymer in addition to the non-stick feature. During this work, emphasis will be placed on the best method to manufacture the face mask in terms of the solidity and non-stick feature which gives a longer life for facemask. The facemask is quicker and more affordable than delivering a treatment or a counteractant, and furthermore gives the facemask better outcomes against the Coronavirus.

ORIGINAL RESEARCH ARTICLE

1. INTRODUCTION

Polyhydroxyalkanoates (PHAs) are microbial thermoplastics displaying comparable mechanical and opposite end-use properties with regular oil inferred polymers [1,2]. They are delivered by an enormous assortment of microorganisms as carbon/vitality stockpiling mixes, under lopsided development conditions[3]. Despite that the presentation of PHAs in the polymer advertise was foreseen to bring about the continuous substitution of normally utilized polymers in different applications, their business accessibility is as of not long ago fundamentally lower than anticipated, because of their expanded creation cost[3,4].

Polyhydroxyalkanoates (PHAs) are biopolyesters combined as carbon and vitality sources by a wide assortment of microorganisms. It has levels of popularity in the business sectors of bundling materials, dispensable things, car parts, and clinical gadgets. The improvement of nanotechnology has encouraged new bits of knowledge into PHA structures, fortification systems, and handling choices. An assortment of potential applications and research patterns are envisioned[5].

The Centers for Disease Control (CDC) suggests that everybody - debilitated or solid - wear a fabric face veil in places where it tends to be difficult to remain 6 feet from others, similar to markets. That is on the grounds that reviews show that individuals can spread coronavirus regardless of whether they don't have indications (called asymptomatic) or before they have manifestations (called presymptomatic). Truth be told, you may be the most infectious not long before side effects start. At the point when somebody who has COVID-19 coughs, sneezes, or talks, they send small beads with the coronavirus into the air. That is the place a veil can help. A face veil covers your mouth and nose. It can hinder the arrival of infection filled beads into the air when you hack or wheeze. This eases back the spread of COVID-19 [6,7].

Proof on non-pharmaceutical general wellbeing measures including utilization of veils to alleviate the hazard and effect of pandemic flu was audited by a workshop gathered by WHO in 2019; the workshop presumed that despite the fact that there was no proof from preliminaries of adequacy in lessening transmission, "there is unthinking believability for the potential viability of this measure", and it suggested that in a serious flu pandemic utilization of veils openly ought to be considered[8,9]. Dismissing a minimal effort intercession, for example, mass concealing as inadequate on the grounds that there is no proof of adequacy in clinical preliminaries is in our view possibly unsafe.

Because of their impossible to miss highlights like very high surface territory to weight proportion, low thickness, just as high pore volume and controllable pore size, which may not be available in different structures, fibers have become the dominant focal point in nanotechnology. The demonstrated properties, therefore, make non-woven fibers as suitable materials for wide-spread applications. Electrospinning, due to its high efficiency, straightforwardness, ease, reproducibility and its possibilities of being used at the modern level is viewed as one of the most potential procedures in nanotechnology. This technique infers the utilization of high voltage electric field expecting to separate extremely thin filaments from a polymeric liquid stream (arrangement or liquefy) possibly deliverable through a millimeter-scale needle. Electrospinning, as a method, is dependent on different preparing norms like arrangement properties and handling parameters[10,11]. Therefore, adjusting these parameters could apply a significant level of effect on the nanofiber size, shape and morphology. Hence, by controlling those parameters well, explicit strands can be delivered to profit different applications as filtering or facemask [10,12,13]. The fiberstructure can catch little nanoparticles noticeable all around stream because of their productive system of Brownian dispersion and block attempt. B. Maze et al[14] detailed through reproduction information that the filtration productivity for nanoparticles can be improved by diminishing the fiber distance across and expanding the stream temperature of the air.

Jing Wang et al, examined channels made out of a layer of fiberstructure on a substrate made of micrometer filaments and think about the exhibition of such nanofiber media to ordinary micrometer stringy channels. The presentation of the nanofiber channels is assessed utilizing the figure of legitimacy, which speaks to the proportion between the filtration proficiency and the pressure drop. Filtration tests were performed on four examples with various fiberstructure solidities. As the fiberstructure strength expands, the filtration effectiveness and the pressure drop both increment. The recreation results are in acceptable concurrence with tests for 20–780 nm particles however errors exist for particles littler than 20 nm. They outcomes show that fiberstructure channels have better figure of legitimacy for particles bigger than

around 100 nm contrasted with customary fiberglass channels[12].

Kristine Graham et al they discussed a procedure for making fiberstructure, just as the advantages, restrictions, development, and execution of channels utilizing nanofiber media. Specifically, fiberstructure give stamped increments in filtration effectiveness at moderately little (and at times vast) diminishes in porousness. In numerous research facility tests and real working conditions, nanofiber channel media likewise exhibit improved channel life and more debase holding limit. Fiberstructure channel media have empowered new degrees of filtration execution in a few different applications with an expansive scope of situations and contaminants. The capacities of fiberstructure did investigated through applications-based execution information[15].

In this work, it will be discussed the importance of using fiberstructure as a facemask to prevent corona virus through the use of a biopolymer characterized by being non-stick[16].

2. EXPERIMENT

2.1. PREPARATION OF POLYHYDROXYALKANOATES (PHAS)

Polyhydroxyalkanoates (PHAs) (MW: ~6.60 × 10^4 g/mol) were prepared as precursor solutions. The PHAs solution was made by dissolving 0.1 g into 10 mL of ethanol (EtOH, 99.9%). The solution was magnetically stirred for 6 hours at room temperature. After that the solution was stirred, the homogeneous solution then took each deposition angle 5 ml transferred to a 10mL plastic syringe, needle (20 gauge). The syringe was placed in a syringe pump and the needle was connected to a high voltage power supply, which could generate a high voltage up to 15 kV. The conditions used to produce TiO2/PVP nanostructure. The electrospinning was optimized as; needle to collector distance of 15 cm, flow rate of (1 ml/h) and voltage of 14 KV. After electrospinning, the fiberstructure were easy removed from the aluminum foil.

2.2. Characterizations Techniques

Morphological surface observations and structural investigations were performed by field emission scanning electron microscopy (FESEM) model FEI Nova NanoSEM 450 [17].

The facemask NFs will prove efficiently when prevent to stick the viruses and contaminants on the surface of the facemask. Addition to it is easily to clean it and ensuring high filtration efficiency and long filter life, those advantages come because of have non-stick feature.

2.3. Face-Mask N95

N95 respirators and surgical masks are examples of personal protective equipment that are used to protect the wearer from airborne particles and from liquid contaminating the face, see **Fig.1**. The Centers for Disease Control and Prevention (CDC) National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) also regulate N95 respirators. It is important to recognize that the optimal way to prevent airborne transmission is to use a combination of interventions from across the hierarchy of controls, not just PPE alone. The Centers for Disease Control and Prevention (CDC) does not recommend that the general public wear N95 respirators to protect themselves from respiratory diseases, including coronavirus (COVID-19).

Long duration wearing of N95 respirator may induce physiological stress, making regular tasks more challenging, and causes headaches among healthcare providers[18]. These effects might be due to the respiratory microclimate change surrounding the masks. For example, wearing surgical facemask and N95 respirator was found to induce different temperatures and humidification on outer and inner mask surfaces. These differences are attributed to

different material properties of the masks, such as lower air permeability and water vapor permeability in N95 respirator[19,20]. While the N95 respirator would physically increase the nasal resistance more than 100% compared to the condition without respirator[21], the presence of exhaled moisture or concurrent wearing of surgical facemask has limited effect on breathing resistance[22,23].

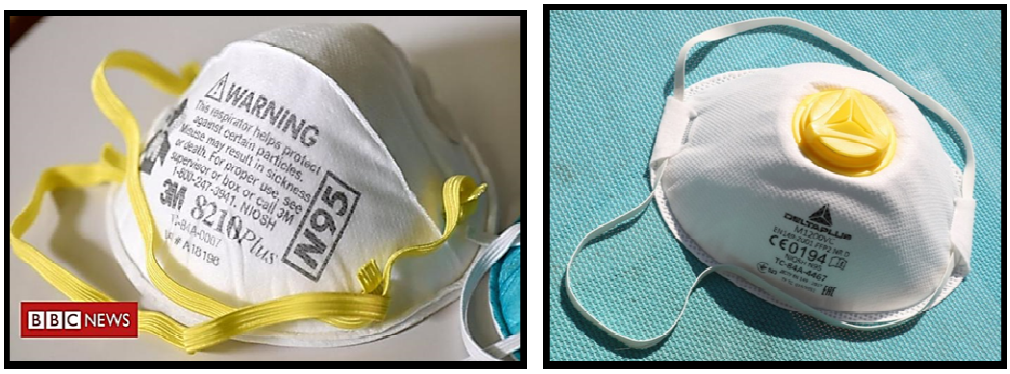

Fig. 1: Image of N95 face-mask

World Health Organization has confirmed that wearing surgical mask is effective in controlling the spread of respiratory diseases in the community, but the supply may not be able to satisfy all the demands created all over the world in a short period of time.

C.Y. Suen et al[24], they did study possibility to extend the lifespan of N95 respirator, where surgical mask become critical during pandemic. This investigation found that dry heat and UVC irradiance could effectively disinfect the mask material without creating significant damage to surgical mask. The steamed and boiled samples which demonstrated a tarnished and softened appearance respectively. Earloop of the samples after boiling, steaming and autoclave treatment lost elasticity. SEM was chosen to note any micro structural change of masks after different treatments.

Fig.2 shows the structure of the mask N95 under a microscope, as it shows an irregular structure, as in **Fig.2a**, in **Fig.2b** showed that the density is not high, although it is four layers. Showing a weak structure and high inefficiency for continuous use, unlike what would be made by a biopolymer PHAs, it characterized by high flexibility and ef

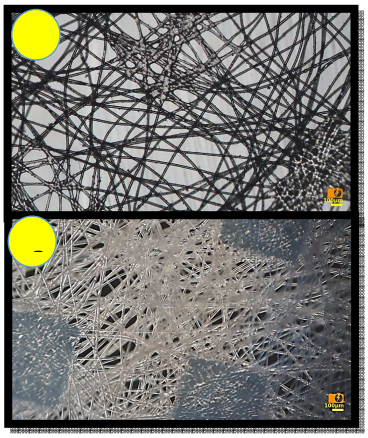

Fig. 2: N95 mask under microscope

3. FESEM Observations

Fig. 3 shows the formation of fibers with a close diameter around from 1mm. In addition, the fibers have smooth surfaces and are interconnected forming a network–type of microstructure. Different parameters are responsible to control the morphology of PHAs such as type of concentration of PHAs solution. Electrospinning showed a regular microstructure with same diameter of fibers. SEM analysis also showed that many of these fibers are fabricated due to polymers nature. Where the polymer used is plastic, it gives importance in terms of the elongation of the polymer by using electrospinning to give fiberstructure regular and dense. During fiber formation by electrospinning, a jet of polymer solution is subjected to the effect of humidity and temperature[25,26]. The high voltage that acts upon the polymer solutions is therefore considered responsible for fiber stretching and, ultimately, for fiber diameter distribution[27,28]. Microfiber better than nanofiber to fabricate face-mask, where it allows easier exhalation, prevent humidity and reduce uncomfortable heat and carbon dioxide buildup inside the mask.

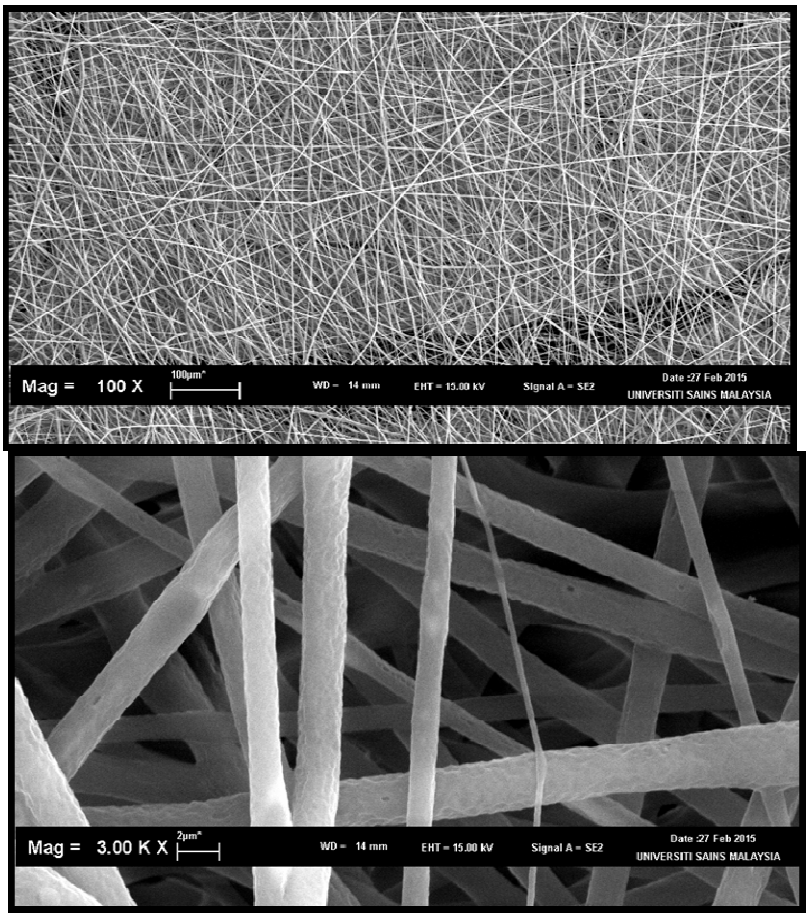

Fig. 3: SEM images of fiberstructure with different magnification

The efficiency of filtration has a linear relationship with fiberstructure solidity and pressure drop, where the fiber solidity depend on the diameter of nanofiber[12]. The SEM showed high density and big diameter of fiberstructure because of the PHAs is plastic polymer, where it needs more distance and higher voltage to allow it to elongate more to reduce the diameter of the fibers. The diameter of fiberstructure around 1 µm will be more

solidity than small diameter, Hence better efficiency. Has been note increased filtration efficiency for aerosol was observed for relatively higher pressure drop [29,30]. According to Darcy's law the relationship between pressure drop and air velocity is directly[12,31], and since the spray speed during sneezing and coughing is high, the face mask fibers will achieve excellent results.

4. CONCLUSION

The high and regular fiber density gives a great advantage to make it important in the manufacture of facial mask to protect against coronavirus. The SEM results showed a high density of fibro structure with an 1µm diameter, as these results achieve increased fiber solidity with pressure drop. If consideration is given to what was stated in this paper, it will give everyone a quiet and safe life to live with the Coronavirus. Prevention always gives better results from treatment, especially with viruses. The manufacture of a face mask is faster and less expensive than producing a treatment or an antidote, and also gives the face mask better results against the Corona virus

Data Availability Statement: The data presented in this study are available in this article.

Conflicts of Interest: The author declare no potential conflict of interest.

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