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# PREPARATION HEALTH MASK FROM CHITOSAN NANOFIBERS FOR FILTRATION

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**ABSTRACT:** Considering, mechanism and modernism of cities and industries there are much dangerous pollution around our location especially in cities that can be the reason of loses of many lives .In the other way considering the effects of the air pollution in the health of the human is daily increasing. Also in this research, the goal of manufacturing chitosan nanofibers was to investigate and eliminate the existing polluters in the air. In order to manufacture chitosan nanofibers, electrospinning equipment with different densities of chitosan solution was used and then the manufactured "web" was utilized to prepare a mask for measuring the amount of eliminated polluters. To achieve this, first the effects of different factors such as chitosan density, the applied voltage to the solution, the distance between the opening and the collecting plate and the rate of feeding the spinning solution were investigated. In the next stage, the microstructure of the manufactured nanofibers was investigated using Electronic Microscope (SEM). This was followed by experimenting with the prepared filter together with a mask available in the market, by exposing them to polluted air for 5 hours, in order to investigate the amount of eliminated polluter using the EDX test. The SEM micrographs showed that the diameter of the manufactured nanofibers is between 100 and 500 nanometers, under different conditions. Also, the results obtained from "elemental" analysis showed that the prepared filters are completely capable of eliminating metal polluters such as Pb, Cd, Sb, etc and it is possible to use these nanofibers in preparing health masks for air filtering.
***Keywords:*** Chitosan, Filtration, Nanofibers, air pollution, Health

## INTRODUCTION

Air pollution is a controversial issue caused by industrial civilization, indeed without using air filtration equipments, human body is more exposure to air polluters. According to increase the effects of air pollutant on the health of human, using of air filters which are capable of elimination of metal polluters is necessary.
Nanofibers are defined as fibers with diameters less than 500 nm that the most common type of nanofibers is produced from polymers. Indeed nanofibers are produced through two different methods including: elctrospinning and wetspinning , that in both methods the polymer solution is extended to be narrow in nanometer dimension. The most important advantages of nanofibers in comparison with common fibers are the dimension of nanofibers and their stability that using of them in the production of air filters leads to better results. (Zhou, 2008)
In this research the goal of manufacturing chitosan nanofibers was to investigate and eliminate the exciting polluters in the air. Therefore, chitosan nanofibers were produced through using of different concentration of chitosan solution and electrospinning, and then the produced chitosan nanofibers were investigated by using Scanning electron microscope (SEM).
Many studies were performed about air filtration but the difference between them is using different polymers and methods, in this project natural chitosan polymer was used through nanotechnology.
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their stability that using of them in the production of air filters leads to better results. (Pillai C. K. S., 2009; K. Sun, 2011)

Chitosan is a linear polysaccharide composed of randomly distributed β-(1-4)-linked D-glucosamine and N-acetyl-D-glucosamine that has special properties that result in using of them in different industries. The features of chitosan including: lipotropic, environmental friendly, availability, cost effective and the most important feature is chitosan consists of Nitrogen functional group. Considering the Cationic Property of chitosan the chain molecule of chitosan surrounds the suspended solid , minerals and heavy metals including : Zn, Cr, As, TiO2, P, and specially Hg, Pb, U, amino acids and proteins, that results in clotting of them.( Dutta P,2004; Haider S,2009; Desai K, 2009)

Also chitosan is used in absorbance of radioactive materials and purging of oil and greasy, toxic, aromatic and specially polchlorobiphenyls (PCBs). According to the mentioned features and properties of chitosan nanofibers(Christian Burger, 2006), this study is based on investigation of decreasing air pollution by using chitosan nanofibers technology.

Aims and objective:

1. Production of chitosan nanofibers through using electrospinning method
2. Investigating the role of chitosan concentration on the electrospinning process
3. Investigating the role of solvent on the electrospinning process
4. Production of Web of chitosan nanofibers to use in exciting filters.
5. Investigating the role of web of nanofibers which are used in filters on the optimal breathing.

## MATERIALS AND METHODS

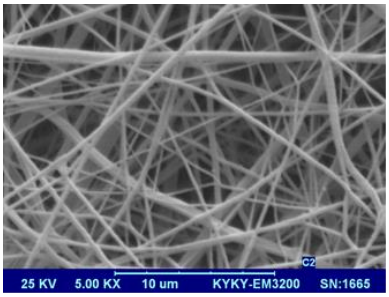
Chitosan nanofibers were produced from chitosan powder with medium molecular weight from Sigma, Trifluoroacetic acid (%98) and Dichloromethane (%99) from Merck (Germany). Sodium hydroxide, sodium carbonate and potassium carbonate from Merck (Germany) were used as neutralizing agents. Electrospinning from Fanavaran Nano-Meghyas Iran was used to produce Web of chitosan nanofibers and scanning electron microscope (SEM) with Energy-dispersive X-ray spectroscopy (EDX) from CamScan was used to observe uneven surface and investigate the rate of absorbance of polluters. Sputter Coater (SCDOOS) from BAL-TEC from Switzerland was used to semiconductor manufacturing and also this device helps fibers to become visible through SEM.

To produce the soluble spinning, % 1.7 of chitosan powder was added to the solution of Trifluoroacetic acid and dichloromethane (7:3). The solution was homogenized on the magnetic stirrer for 6 hours. Then the homogenized solution was injected to the electrospinning by 10ml syringe. The voltage of electrospinning was 15 kv that electric field between opening and collecting plate causes transferring polymer solution. The polymer solution affected by propulsion of potential difference between opening and collecting plate was strongly extended and becoming nanofibers. The distance between opening and collecting plate was 15 cm and the feed rate was 1ml/min that those rate was controlled by spinning pomp. The produced fibers were stuck on the collecting plate that results in the production of layer looks like paper or web. Then the structured nanofiber mass was neutralized by basic solutions such as: sodium carbonate and sodium hydroxide and subsequently washing by distilled water. Then, the nanofiber mass was dried for 24 hours at 60°C in the oven. The prepared fiber was fixed on the normal air mask and the complex was exposed to air pollutant for 5 hours then the mask including chitosan nanofibers was compared to the normal mask in the same situation as a control by EDX experiment.

## RESULTS AND DISCUSSION

In order to obtain the optimum conditions for manufacturing chitosan nanofibers, the effect of density, the electrospinning equipment voltage, the distance between the opening and the collecting plate and the effect of spinning solution feeding rate, using SEM photos, have been investigated.

First, in order to investigate the effect of density, “webs” with molecular mass percentages of 1.3, 1.5, 1.7 and 1.9 were prepared. The webs from 1.3 and 1.5 densities were formed as “moths” while the one from 1.9 consistent was formed as “puff”. Therefore, from that point on, density of 1.7 has been used as the optimum density (Fig.1).



Figue1. %1.7 wt consistent

Next, to investigate the effect of equipment voltage, voltages of 15, 17 and 20 kV have been considered. At 20kV, due to the increase in the traction resulting from the electrical potential difference, the formed mass contained “moths” and since noticeable differences were not observed between 15kV and 17kV, the 15kV voltage has been selected as the optimum choice, due to its lower use of consumed energy (Fig. 2)

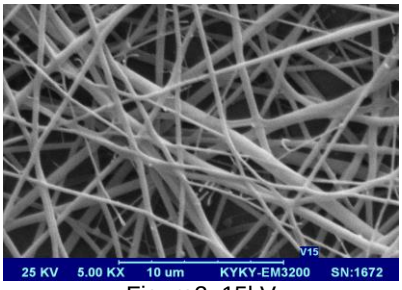


Figure2. 15kV

In the next step, the effect of the distance between the opening and the collecting plate has been investigated. To do this, the distances of 10, 13 and 15 centimeters have been examined. At the 10 cm distance, the diameters of the fibers were relatively high and at the 15cm distance, as a result of the increasing distance, the fibers were slashed and formed as “moths”. Therefore, the optimum distance of 13cm has been selected (Fig. 3).

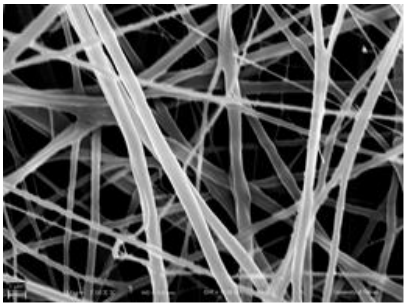


Figure3. 13cm distance

In order to investigate the effect of the feeding rate, indices of 0.5 ml per minute and 1 ml per minute have been considered. The photos obtained have shown that the fibers obtained at the feeding rate of 1 ml per minute were more uniform (Fig. 4).

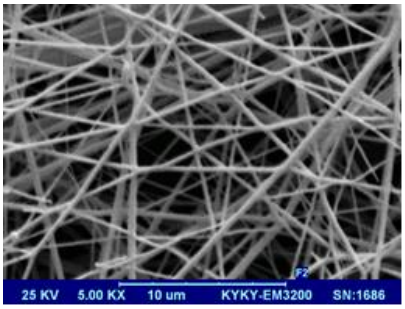



Figure4. 1 ml per minute

Taking into account the optimum conditions obtained and mentioned previously, the chitosan nanofibers have been prepared. These nanofibers have then been installed in the membrane of a regular mask available in the market. Then using a regular unmodified mask for comparison, under identical conditions at a time when the index of suspended particles under 2.5 microns in air has been 128 (Fig. 5), which is considered unhealthy conditions under standard air pollution metrics, both samples (the sample with nanofibers and the unmodified sample) have been exposed to pollution for 5 hours and the results for both samples have been compared and investigated (Figs. 6 and 7).

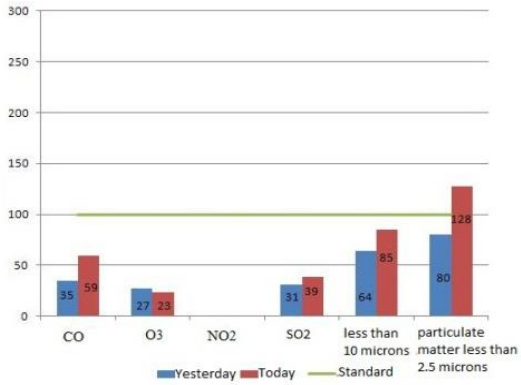
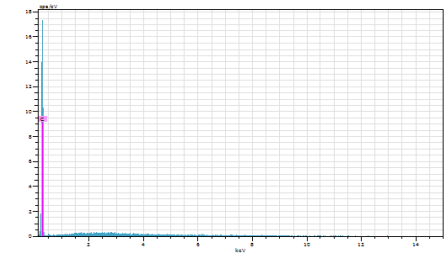


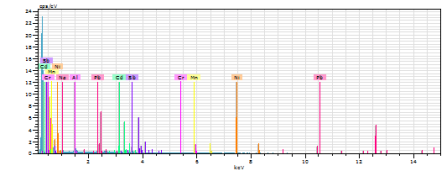

Figure5. Air pollution index



3218 Date:1/11/2013 4:39:36 PM HV:15.0kV Puls th.:2.27kcps

| El | AN | Series | unn. C [wt.%] | norm. C [wt.%] | Atom. C [at.%] | Error [wt.%] |
|---|---|---|---|---|---|---|
| C | 6 | K-series | 100.00 | 100.00 | 100.00 | 13.8 |
| | | Total: | 100.00 | 100.00 | 100.00 | |

Figure6. EDX for normal mask



1-1 Date:1/11/2013 4:37:00 PM HV:15.0kV Puls th.:3.05kcps

| El | AN | Series | unn. C [wt.%] | norm. C [wt.%] | Atom. C [at.%] | Error [wt.%] |
|---|---|---|---|---|---|---|
| Na | 11 | K-series | 0.63 | 18.54 | 30.77 | 0.1 |
| Al | 13 | K-series | 1.43 | 41.75 | 59.04 | 0.1 |
| Cr | 24 | K-series | 0.00 | 0.03 | 0.02 | 0.0 |
| Mn | 25 | K-series | 0.00 | 0.03 | 0.02 | 0.0 |
| Ni | 28 | K-series | 0.00 | 0.03 | 0.02 | 0.0 |
| Cd | 48 | L-series | 0.13 | 3.70 | 1.26 | 0.0 |
| Sb | 51 | L-series | 0.60 | 17.42 | 5.46 | 0.1 |
| Pb | 82 | M-series | 0.63 | 18.49 | 3.41 | 0.1 |
| | | Total: | 3.42 | 100.00 | 100.00 | |

Figure7. EDX for nanochitosan mask

## CONCLUSION

In this research at the first step, the optimal situation for producing chitosan nanofibers was investigated that according to the results, %1.7 wt consistent, 15 kilo voltage , 1 ml/min feed rate and 13cm distance between opening and colleting plate leading to the best results. Then the analysis of both air masks by EDAX was shown that in the air mask with chitosan nanofibers more metal polluters were absorbed in comparison with normal air masks. For future work, using other polymers which are suitable for spinning and also using chitosan nanofibers for water filtration and industrial waste is suggested. Moreover, using chitosan nanofibers beyond filtration and applying better methods for exposing produced filters to pollutant air can be investigated in future.

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