INFLUENCES OF PARTICLES AND ELECTROSTATIC BLOWING ON FORMING COMPOSITE MATERIALS

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Abstract

This research is focused on investigation of effects of needleless electrospinning and blowing method. These methods are used for electrospinning and particle incorporation to make the final product. Particles are incorporated during electrospinning by special sputtering equipment to the blowing air. Diffuser for blowing air is placed between the electrospinning collector and sputtering equipment. This arrangement will help to create compound consisted of particles and nanofibers. These techniques are used for preparation of new composite materials which are voluminous and fluffy nanofibrous layer.

Keywords: Needleless electrospinning, incorporation of particles, blowing method

1. INTRODUCTION

Nanofibrous materials are used for specific surface area and pore size. They are famous for specific diameter which is mainly in ratio 100 – 700 nm and are known as submicron fibres. In this time there are used at least 5 techniques which lead to production of nanofibrous material or layers. One of them is needle–less electrospinning called Nanospider. There are many commercial machines for production nanofibrous layers in this time. The nanofibrous materials are used as composites materials. The composites and synergic effect shows new properties [1]. Composite materials are also known as heterogeneous systems, which are consisting of at least two phases. Each phase has different properties and thanks to these properties and synergic effect can be created new material [2].

This article focuses on composite material which is a polymer matrix (nanofibrous material) and the particles of active carbon which are displaced. This composite material is called “nanofibrous with carbon” [3]. The active carbon particles are used for a specific surface area. The sorption mechanism of carbon particles is the most effective mechanism. They are known as particles where the active carbon is used as a filter or as a sorption agent. Because of the combination of nanofibers and carbon we chose this composite as a filter in filtration masks [4].

2. RESULTS

For the experiment was used polymer polyvinyl butyral (PVB). This polymer was made by the Kurakay company. It was delivered as pellets with optical clarity and prepared from polyvinylalkohol by reaction with buraldahyde. Thank to strong binding properties it is used as adhesion to many surfaces. Polyvinyl butyral (PVB) polymer was used in molecule weight 75.000, and it was dissolved to final concentration 7wt% percent. As a solvent was used ethanol. Electrospinning equipment is depicted in Fig.1A.

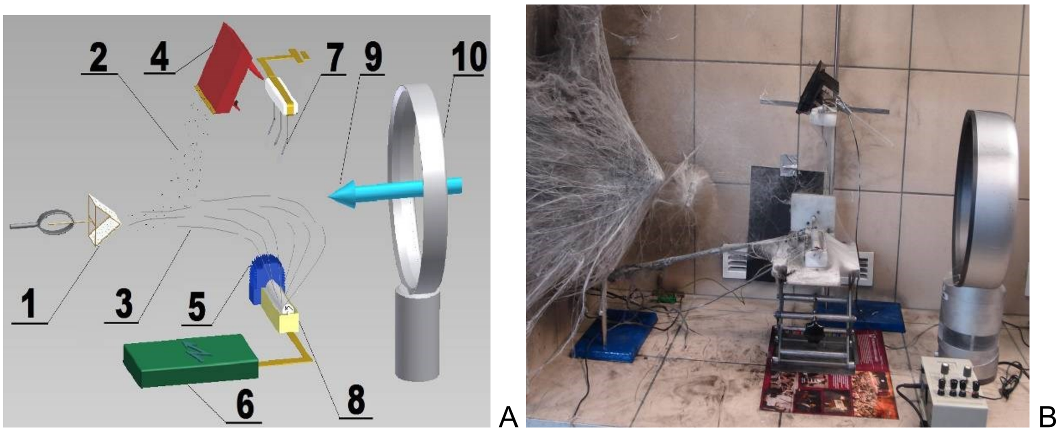

Fig.1A Schematic view of electrospinning equipment and air blowing equipment. 1-wooden frame in holder and deposited nanofibrous layer, 2-active carbon particles, 3-nanofibres, 4-box with active carbon and dosing apparatus, 5-engine connected with roller, 6-high voltage supply source, 7-grounded needle collector, 8-nanospider, 9-focused smooth air, 10-blade less air multiplier. Fig.1B: Experimental setup placed in the digester.

The arrangement was settled inside a digester depicted in Fig.1B. Air convection was homogenous thank to conditions inside a digested and air multiplier. Air was accelerated through a 1.3mm aperture. This creates an annular jet of air that passes over an airfoil – shaped ramp. Surrounding air inside the digester was drawn into the airflow. This technology gives a stream of smooth air which is depicted in Fig. 1 by position 9. The focused smooth air flow was set in the middle between the nanospider and collector. Nanofibers were created on roller surface and they were attracted to the collector. The focused air blows the fibres and active carbon particles to the surface of collector. Nanofibers were mixed with carbon particles inside the air. As mentioned above in background PVB is very adhesive polymer and therefore the particles were fixed very firmly with nanofibers.

Thanks to the combination of nanospider electrospinning and air blowing technologies it was reached the fluffy and voluminous material which is depicted in Fig. 2, 3. Active carbon particles are fixed on the surface of nanofibers so that they can be used for filtration. The surface of active carbon particles can react with various chemical substances and absorb them. Final nanofibrous layer is depicted in Fig. 2. The point of view is from the top (as focused air). The surface has a white colour and the reason is that the PVB polymer was used without carbon particle as a cover. This can protect the composite material inside and hold carbon particles on position. The reason is that the carbon particles have to be held in the composite material without releasing off. Temperature was 24°C and humidity around RH=45 %.

Fig.2 Surface and dimension of composite nanofibrous material 50x100 mm (Diameter of Czech crown is 20mm)

Fig.3 Cross section of voluminous nanofibers composite material, the thickness 10mm (Diameter of Czech crown is 20mm).

3. DISCUSSION

Prepared nanofibrous layers were observed under electron microscope brand name Tescan. It is possible identify the fluffy structure in Fig.4A and the fringe of nanofibrous material. Fig. 4B shows surface of composite material consist of PVB and active carbon particles. Next SEM picture Fig. 4C shows a detail view to created nanofibers. Figure 4D shows active carbon particles which are firmly fixed. It was measured mass per unit area for blind pattern 33g/m^2 and for composite material 89g/m^2.

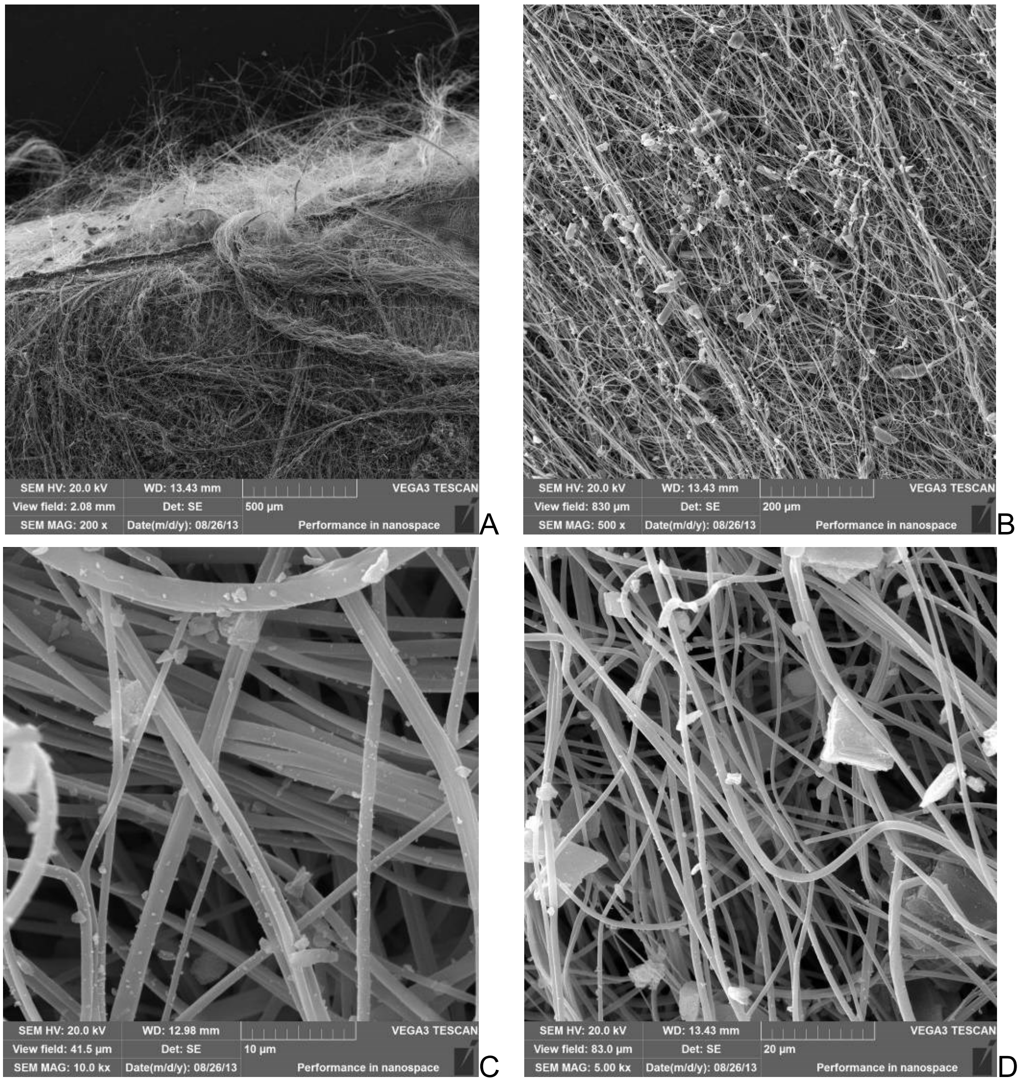

Fig.4 A-SEM fluffy voluminous structure of PVB, B-SEM surface structure, C-SEM detail view to PVB nanofibers and particles, D-SEM detail view to nanofibers with incorporated active carbon particles.

4. CONCLUSION

This article refers about the preparation of the composite material consisting of nanofibers and active carbon. The polyvinylbutyral PVB as a matrix. The final nanofibrous layer is consisting of fibres which diameter is near micron. As showed in the SEM pictures the active carbon is deposited between nanofibers. These micro particles have a free surface which can lead to better absorption. The final composite product can be used as a filter in filtration masks. Thanks to the active carbon they can protect against phenols. Prepared material will be tested as a filter. Results will be known in the following day.

5. ACKNOWLEDGEMENT

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