Development of the technique for the synthesis of the HEPA filter composite material

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For the past couple of decades, the public became witness of the environmental problems that arised from regular intervals. It was associated with the fast advanced urbanization and industrialization. In particular, the US Agency of Environmental Protection in 1997, announced National Ambient Air Quality Standards for Particulate Matter. This Standarts reported that particles smaller than 2.5 microns are the most dangerous sources of air pollution, as well they have an adverse effect on human health, especially on respiratory tract and extrapulmonary organs. According to estimates based on statistical data and composition of the atmosphere air pollution leads to 3.3 million of untimely deaths worldwide Lelieveld et al (2015).

It was developed porous filter for the aerosol particles, which is a hybrid material. The porous structure of the propylene homopolymer, which was obtained using melt-blown technique, is a bearing substrate for woven into it nano and microfibers, Figure 1. In this case nonzero velocity on the nanofibers surface means pressure drop is smaller compared to micrometer fibers, while since particles trajectories lie closer to the fiber surface they have more chances to stick to the fiber surface Hung et al (2011). To create a new filter concept, fiber Nylon-66 obtained by the electrospinning method, deposited on a two-dimensional netlike structure of binding polypropylene micro fibers. The morphology of the resultant structure is determined equal area circle equivalent diameter of the fiber cross-section, the coating speed, wide pores, and packing density of the layers of nanofibers and microfibers. These characteristics can be accurately controlled by varying the physicochemical properties of the working solution (e.g. polymer concentration in solution), as well as experimental electrospinning process parameters (e.g. flow rate).

Table 1. Comparison between some solutions and diameters of the resulting nanofibers

Solution concentration (%)	Fiber diameter (nm)	Specific gravity (g/m^2)
10	79	9.4×10^{-2}
12	89	3.4×10^{-1}

The advantages of nonwoven filter material may include ease of manufacture frameless filter in one work cycle. Among the unique properties of the material should be noted the high filtration efficiency for MPPS is comparable with a HEPA filter pressure drop at the same rate of filtration, as well as a great resource of holding capacity for atmospheric dust. Table 1 shows the parameters obtained nanofibers from solutions of nylon 66. The use of this technology allows you to create filters, which covering a large range of filtration efficiencies up to ULPA class.

Abstract review

The nanofibers (NY66) was deposited on the matrix of microfibers (PP) using the electrospinning technique and charging target with aero ions of opposite sign. As a result, porous material with a unique filtration properties was synthesized. It is shown that changing electrospinning process parameters the optimal morphology of the material could be obtained.

The hybrid and composite filter material with a low-pressure drop and at the same time having a consistently high filtration efficiency for the most penetrating particle size (MPPS) was developed. It was shown that analogue of HEPA filter provides a comparable or even a higher filtration performance and benefits at cost.

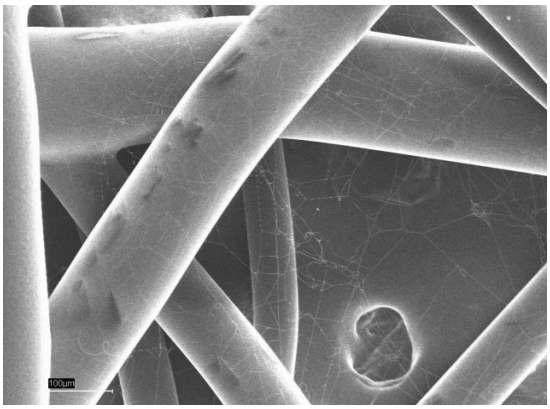

Figure 1. SEM image of a single layer of micro and nano fibers formed with an applied voltage of 50 kV.

Lelieveld, J., Evans, J., Fnais, M., Giannadaki, D. and Pozzer, A. (2015) *Nature* **525**, 367-371.

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