FILTRATION AND ANTIBACTERIAL PROPERTIES OF MODIFIED NONWOVENS

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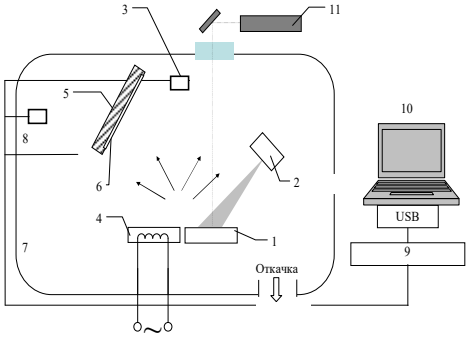
Motivation

One of the important areas of application of nonwoven polymer materials is the creation of individual filtration systems, including medical masks, which becomes extremely relevant in connection with COVID-19. To improve the filtration efficiency among various methods for modifying nonwoven materials, the surface treatment is especially promising from a practical point of view.

The aim of our work is to develop new modifying layers that allow to increase filter parameters of nonwoven polymer based polypropylene materials (brands "Aquaspun"), as well as to give them new antibacterial properties.

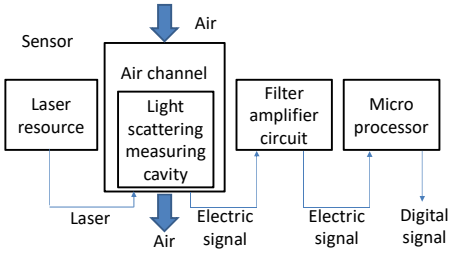
Methods

Plasma-chemical modification of nonwovens
The target was dispersed by an electron beam with an energy of 800–1600 eV and a current density of 0.01–0.03 A / cm^2. The deposition of coatings was carried out at an initial pressure of residual gases in a vacuum chamber of ≈ 4 × 10^{-3} Pa. The thickness of the deposited thin-film systems was monitored using a quartz thickness gauge.

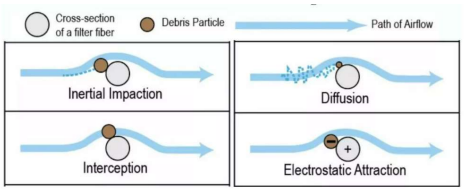


Scheme of formation of a coating from an active gas phase

Particle filtration efficiency
The estimation of PFE was carried out on an experimental laboratory stand (Institute of Chemistry and Science of the NAS of Belarus) by using of the method of evaluating aerosols with a particle size of 0.3 μm to 10 μm.



Particle filtration efficiency

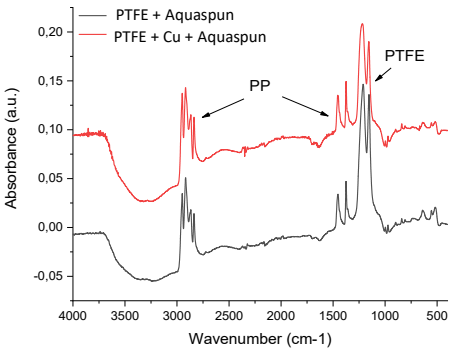


Particle filtration mechanisms

Bacterial filtration efficiency
Determination of BFE of nonwovens was carried out in RUE "Scientific and Practical Center for Hygiene" in accordance with GOST R 58396-2019. Staphylococcus aureus ATCC 6538 was used as a test strain. The working concentration was 5 × 10^5 CFU / ml. The flow rate of the working suspension was 5 μL (2500 CFU / test). Fragments of samples 10 × 10 cm in size were examined, which were facing the marked side in the direction of the acting aerosol.

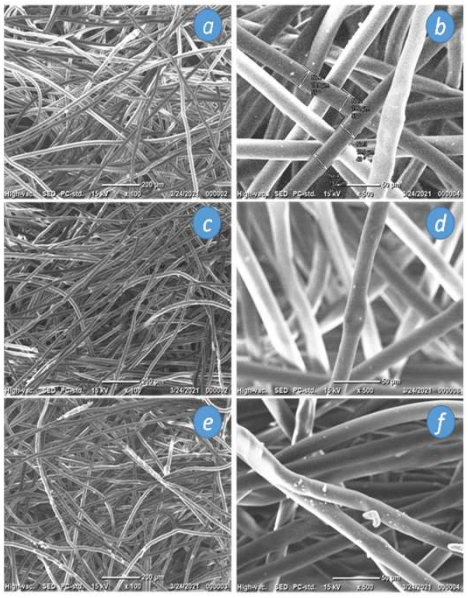
Bacterial filtration efficiency

Results and conclusion



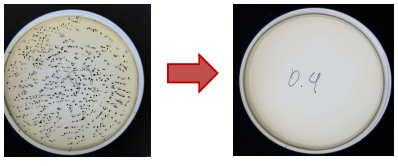
ATR-FTIR spectra of the modified polymer nonwoven material Aquaspun 100

Change of contact angle



SEM images of polymer nonwoven materials at different magnifications: Aquaspun 100 original (a, b), Aquaspun 100+ PTFE (c, d), Aquaspun 100+ PTFE + Cu (e, f).

Mask type	BFE, %	PFE , %
SpunBel40/ PTFE+AquaspunB100/ SpunBel40	90,3–91,6	88,8-90,0
SpunBel40+PTFE+Cu/ PTFE+Cu+Aquaspun B100 / SpunBel40	96,4–97,2	96,7-97,1



Bacterial filtration tests without/ with mask

Using plasma-chemical modification of nonwovens, a significant increase in the filtration properties was achieved, and the presence of micro - and nanoparticles of copper can significantly increase their antibacterial (antiviral) properties.