RR +++ 108 Active Nanosilver Field Mask for Improved Protection Against Bacteria, Virus, and Fungi

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Abstract

As the protective mask available in the market claims only for bacterial filtration efficiency and does not guarantee the virus protection since the size of the virus is much smaller than the pore of the material used in the mask. An effective virus protective face mask was developed using activated nano silver technology. The five layers mask was developed wherein the first and fifth layer was coated with activated nanosilver to impart the antibacterial and antiviral properties.The developed mask (RR+++ 108) has been tested for a reduction in various pathogens. It was found that the developed mask has 99.9% bacterial filtration efficiency (BFE);; 96.3% particulate filtration efficiency (PFE);; 99.4% virus reduction efficiency (VRE);; 99.9% virus filteration efficiency (VFE);; 64.8 % fungus reduction efficiency;; and also resistance to MILD DEW and ROT up to 96 hours. It has also been found to be very effective against H3N2 INFLUENZA A VIRUS , HCOV 229E, which are from the enveloped family similar to SARS COV 2 . The developed mask has shown virus reduction in just 30 seconds only . It is comfortable to wear for a long duration of time up to 8hrs and is Hypoallergenic. .

Keywords

Nano Silver, Bacterial Filtration Efficiency (BFE), PFE and VRE

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1. Introduction

Maharashtra has become the first state to lift all Covid curbs almost after two years. Now the mask is not mandatory in public places. At the same time, it has been advised to keep wearing a mask for the health and safety of all. On the contrary, China has again declared an emergency and imposed the lockdown in Shanghai after a new surge in asymptomatic cases in April 2022. According to the available information, the first case of coronavirus was reported in Wuhan, China in November 2019, and soon after it was found to be rapid spread all over the world and has been set off a global pandemic by World Health Organisation (WHO). The pandemic has necessitated body protection from virus, mainly nose and mouth. N95 was tested as the best option as it was available immediately since it was developed almost 20 years back as protection from dust and large aerosol particulates [1,2]. As we have witnessed three waves of Covid 19 in India and there are debates on the upcoming 4th wave. Under such circumstances, it is important to take necessary steps to safeguard yourselves as well as every individual.

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WHO has given 15 Covid appropriate behaviors to maintain health and safety. Out of which wearing a mask is the simplest and easiest way to follow. Though the Maharashtra Government has announced relief on wearing a mask it is always good to take care of ourselves as the new stream of Coronavirus is seen in Shanghai currently and there are high possibilities that it may again spread worldwide within no time. Under such circumstances, it is advised to wear a mask no matter if it is mandatory or not. Now the question arises, what kind of mask is good and who should wear what type of mask? At present, there are a variety of masks available in the market. Those masks are broadly categorised as fabric masks, protective masks (3ply), and a respirator (N95 type). The differences between each with its advantages and limitations are given in table 1. As seen from the table it is clear that a respirator (N 95 type) gives a higher level of protection but it is recommended to be used by healthcare professionals and frontline workers only. However, we have seen that many doctors and frontline workers are contracting the virus and getting infected by the corona virus. The main reason behind this is the testing standard requirement. Most of the N95 masks are tested for Bacterial Filtration Efficiency and Particulate Filtration Efficiency (BFE & PFE %) against the particulate size of 0.30 micron. Nonetheless, SARS COV2 Covid 19 virus is of size between 0.05 to 0.12 micron. This itself is self-explanatory that the virus can pass through the layers of the N95 mask [3-5].

Table 1. Understanding the difference between various masks available on the market

Particulars	Cloth Mask	Protective Mask (3ply)	Respirator (N95 type)
Intended use	Common people	Medical purpose	Health providers and front-line workers
Filtration level	Low level No fluid resistance Leakage thought fabric	Moderate level Resistance to fluid Leakage from sides	High level Resistance to small airborne particles No leakage
Fitting	Loose depends on the design	Loose fit	Tight fit
Usability	Reusable, need to wash after every use	Discard after every use	Discard after every use

Considering the above fact, we have developed an improved mask RR+++ (108) based on active nano silver coating. Silver ions are microbial and bind irreversibly with the electron transport components. They suppress the respiratory enzyme and interfere with the DNA function, thus, not only destroying virus & bacteria but also preventing proliferation and effectively giving long-duration microbial protection.

2. RR+++ Mask Vs N95 mask

A step-wise comparison of the RR+++ Mask with the N95 mask is given below. Normally, N 95 masks are made by combining 5 different layers of nonwoven material mostly using polypropylene (PP) fibers. The first and 5th layers are made up of 40 GSM PP nonwoven, 2nd and 4th layers are of 30 GSM melt-blown nonwoven and the middle layer is needle punched nonwoven. RR+++ mask also has five layers.

2.1 Comparison of the 1stand 5th layers

The 1stlayer is coated with activated nanosilver by electrospinning method to fight against the microbes present in the atmosphere. The mechanism of the silver ions on the nonwoven fabric is shown in figure 1.

As can be seen from figure 1B the nonwoven used in the N95 mask has a large pore size that the virus and bacteria can easily pass through as they are very small in size in the range of 0.05 to 0.12 micron. moreover, the viruses in Brownian movements can easily pass through the layers of the N95 mask. On the other hand, figure 1A represents the RR+++ mask developed using nanosilvernonwoven fabric. It is coated with an active nano-silver which has a positive charge on it and works as an Israel missile shield by electrostatic attraction. Nanosilver also has the affinity to the sulfur protein present in the bacterial and virus-cell and hence gets attached to the cell wall and envelop gets ruptured rendering it neutralised and ineffective [6-8]. Silver ions interfere with the DNA function , preventing the bacteria, virus , pathogens from performing the most basic function and also preventing proliferation and effectively giving long-duration microbial protection.

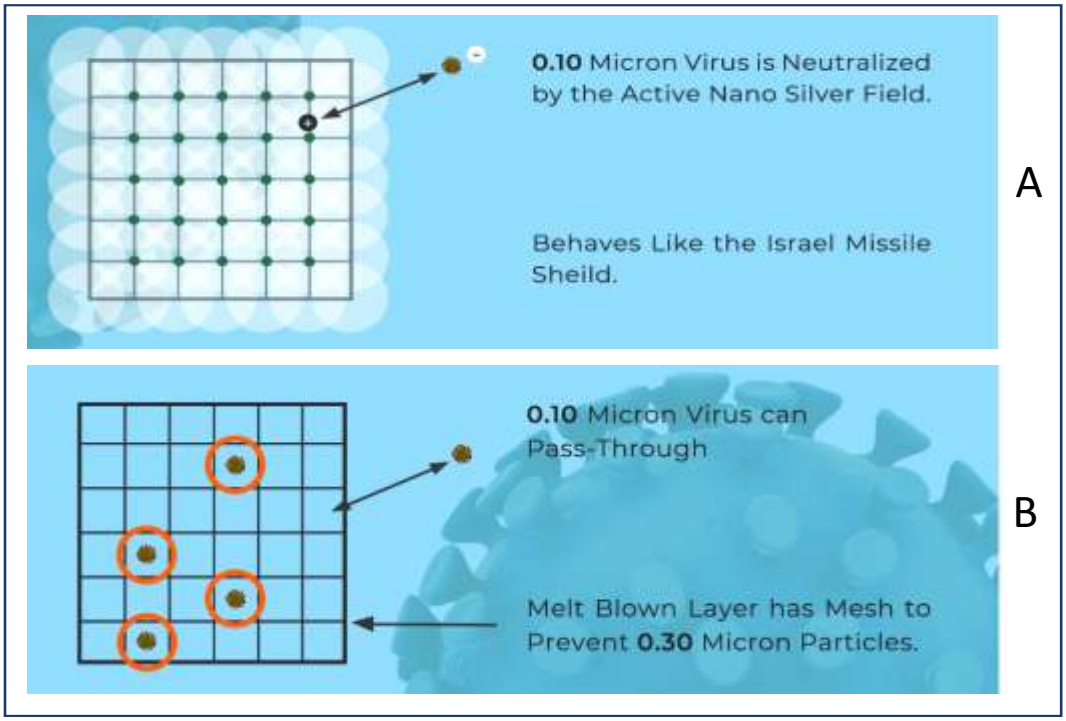
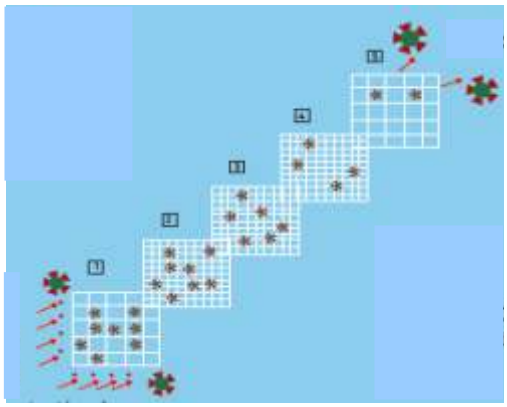


Figure 1 Comparative magnified look/behavior of nonwoven material used in the first layer of mask A- RR+++ mask, B- N95 mask

2.2 Comparison of the 2nd and 4th layer

In general, 30 GSM melt-blown nonwoven material is used in the N95 mask as the 2nd and 4th layer which acts as a filter for the bacterial, virus, and any dust particles. In the RR+++ mask, we have fine filters to prevent the penetration of any bacterial and virus. Typically, filtration mechanisms of any particulate are classified using four basic theories. Thoseinclude a. Impaction; b. Interception; c. Diffusion and d. Electrostatic attraction

A



B

Figure 2 Filtration mechanism of the different layers A- RR+++ mask, B- N95 mask

Normal N95 masks work on the basic filtration mechanism of interception. Wherein the particulates, bacteria, and viruses larger than the pore size get filtered out and the remaining get passed on to the next layer. As we can see from figure 2B the viruses are passing throughout the layers and reaching to the nose of the wearer hence, we saw many doctors and frontline workers contracting the virus and getting infected.

RR+++ mask has the first layer treated with active nano-silver which kills the maximum bacteria and virus at the 1st layer only by Electrostatic attraction mechanism as the spick of the viruses has a negative charge and silver ions are positively charged. Further, the fine filters used in the 2nd and 4th layers removed the remaining pathogens leaving only clean air to reach the wearer's nose. The middle layer in both masks is a soft pad of needle punched nonwoven material to provide comfort.

3. Testing and results:

Table 2 summarises the test requirement as per various national and international standard specifications for a protective face mask. Most of the standards mentioned requirements of breathing resistance, bacterial filtration efficiency (BFE), and particulate filtration efficiency (PFE). It should be noted that none of the standards mentioned the requirement for virus filtration efficiency (VFE). The viruses are much smaller than the bacteria and more resistant to killing than bacteria. The size of bacteria is about 0.4 microns whereas the size of virus ranges from 0.02 to 0.25 microns. Hence, the mask which is claimed to provide a very good BFE of about 99% may not be as effective against the SARS COV2 Covid 19 virus, Alpha, Beta, Gamma, and Delta (fungus infection) to Omicron variant family.

Table 2 Test required as per the specification of various national and international standards

Tests	ASTM F3502	ASTM F2100	IS 16289	IS 9473	EN 14683
Breathing resistance	✓	✓	✓	✓	✓
Bacterial filtration efficiency (BFE)	×	✓	✓	×	✓
Virus filtration efficiency (VFE)	×	×	×	×	×
Particulate filtration efficiency (PFE)	✓	✓	✓	✓	×
Splash resistance	×	✓	✓	×	×
Microbial cleanliness	×	×	×	×	✓
Virus Reduction efficiency (VRE)	×	×	×	×	×

We have tested our developed mask RR+++ for the BFE, PFE, VRE (Virus Reduction Efficiency), VFE, FRE (Fungus reduction efficiency), MILD DEW, and ROT Resistance up to 96 hours and also tested for HCOV 229E virus reduction. We have found very good results for each test. In every test, we have received an almost 99% reduction. From those results, it may be concluded that our developed mask has improved protection against most pathogens and is very comfortable to wear for a long duration. Further, the RR+++ has been found to have a 99.99% reduction for the H3N2 INFLUENZA virus which is a much smaller size virus than SARS COV2. This implies the super virus reduction properties.

This implies the super virus reduction properties specially against enveloped viruses . It is to be noted that Non

Enveloped Viruses are not as harmful as compared to the enveloped Viruses (SARS COV 2) which are highly transmissible and lethal .

4. Conclusions:

Activated nanosilver was coated onto the nonwoven fabric that is used as 1st and 5th layers for the development of a virus protection mask. The developed RR+++ (model 108) mask was tested for its performance for filtration of bacteria and particulate and reduction of various viruses. The results showed a very good efficiency for bacteria and particulate filtration. Test Results of the mask has shown very good efficacy of virus reduction from SARS COV 2 and its subsequent evolved variants of Alpha , Beta, Gamma, Delta (fungus infection) to the Omicron Variant and all othe Variants in future will also be neutralisied . Sars COV 2 , H3N2 Influenza A , HCOV 229 E viruses are from different segments of same family and Omicron is a new emerged variant . Also the new BA1 , BA 2 variants emerging will be neutralised by this mask

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Advanced New JEOL JSM IT 200 LV Scanning Electron Microscope

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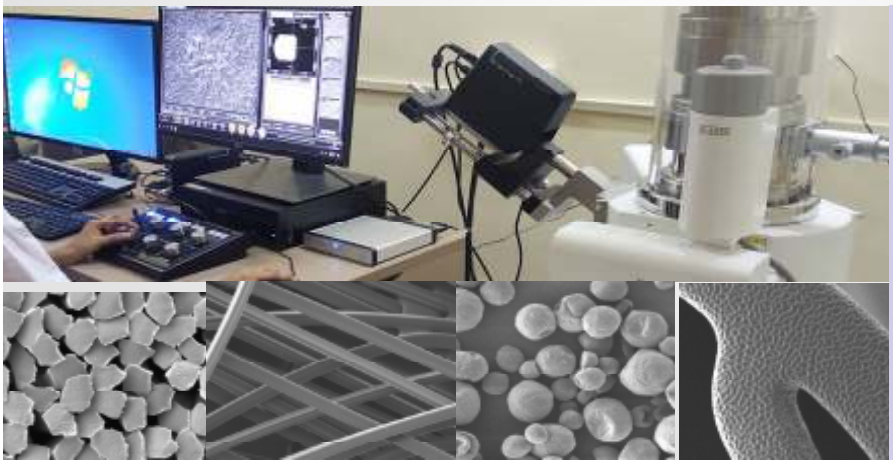
Samples from **Textile, Pharmaceuticals, Ceramics, Polymers, Metals and other allied industries** can be analysed on this SEM machine.



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