DESIGN AND DEVELOPMENT OFANTIMICROBIAL COATED NON-WOVEN FIVE LAYER -N-95 MASK

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ABSTRACT

The masks are act as an efficient tool against environmental threats. So, the mask should be completely safe to the wearer. On such cases our mask will be act as an efficient tool against all environmental threats. We are going to design and develop an N-95 mask which is five layers, contains polypropylene spun bond and melt bond, hot air cotton mesh and blue silver solution act as an antimicrobial agent. We are going to do a plasma treatment to our fabric to increase the water observance by treating the fabric with oxygen gas in standard manner. Plasma technology is an eco-friendly process and resource efficient in nature. And we are going to do some standard test which is required for the construction of mask like, bacterial efficiency test, splash resistance test, air permeability test, comfortability test, breathability test. The filtration efficiency of the nowadays mask is not constant, because the particles have completely different sizes, shapes, and properties. Therefore, we have to decrease the penetration by increase the filtration efficiency of our mask at any conditions. To realize this idea, data regarding the mechanisms of the penetration of the aerosols through the masks at completely different effective environmental. The antimicrobial agent blue silver solution is coated into the fabric by dip and dry method and then the quality of the fabric is studied. At last, we are going to do wear study after the construction of mask. During COVID-19 people had to wear face mask for long hours during working and travelling they report adverse skin reactions after wearing masks daily. The highest incidence of conditions included acne, facial itch and rash. A proper fit over your nose and mouth to prevent leaks. This special type of N-95 mask will be designed and constructed with antimicrobial agent. Our product is completely sustainable product and also, we are planned to sell the mask for very reasonable price rate of Rs.15.

Keywords: Polypropylene, Plasma treatment, Antimicrobial, filtration efficiency, blue silver, Splash resistance, breathability, Five layer

1. INTRODUCTION

Masks area unit an easy barrier to assist forestall your metabolism droplets from reaching others. Studies show that masks can scale back the spray of droplets once worn over the nose and mouth. The people should wear a mask, even though you are doing not feel sick. as a result of the masks area unit used as a part of a comprehensive strategy of measures to restrict transmission and save lives; the utilization of a mask alone isn't comfortable to supply an adequate level of protection against COVID-19. So, the face covering limit is that the volume and travel distance of breath droplets spread once talking, breathing, and coughing. A face covering while not vents or holes also will separate out particles containing the virus from indrawn and exhaled air, reducing the possibilities of infection. N-95 masks are thus known as a result of they're a U.S. standard that needs masks to be able to separate out a minimum of ninety fifth of terrible tiny particles, as well as droplets containing the coronavirus. N95 classification of air filtration, that means that it filters a minimum of ninety fifth of mobile particles. Respirator masks, just like the N95 Mask, are terribly almost like face masks in form, however are additional capable of protective against tiny contaminated mobile particulates. The special classes of nonwoven materials area unit loosely outlined as sheet or net structures secure along by entangling fibre or filaments automatically, thermally, or with chemicals. they're not created by weaving or knitting and don't need changing the fibers to yarn. Nonwoven's area unit factory-made by high-speed and inexpensive processes. As

compared to the normal woven and knitting technology, a bigger volume of materials can be made at a lower price by using nonwoven technology. The construction of an N95 Respirator Mask is intended to suit the mask closely to the face, eliminating the gap that regular face masks have. The various layers of mask like,

First Layer- Hydrophobic Spun Bond
Second Layer - Melt Blown

Third Layer- Hot Air Cotton Mesh
Fourth Layer- Melt Blown
Fifth Layer - Hydrophobic Spun Bond

After the production of nonwoven materials for mask, the antimicrobial coating is given to the materials for extreme protection and are well known for their antifungal and antibacterial arresting property.

Polypropylene is the new material for COVID-19 mask filters. For community mask manufacture, we suggest using industry-grade spun bond polypropylene. Every study that has looked into layering in face masks has found that adding more layers increases filtration, however some textiles produce better filtration than others. We agree with the public health statement and advocate using industry-grade "spun bond" polypropylene in particular. The structure of traditional clothing and furnishing materials is woven or knitted. Nonwoven fabrics, on the other hand, have a random distribution of fibres, similar to spaghetti on a plate. This randomization allows for effective particle filtering while keeping airflow at a high level. There are many types of non-woven polypropylene. Spun bond, melt blown, and spun lace materials are the most frequent. The structure of traditional clothing and furnishing materials is woven or knitted. Nonwoven fabrics, on the other hand, have a random distribution of fibres, similar to spaghetti on a plate. While maintaining a high amount of airflow, this randomization allows for effective particle filtering. There are many types of non-woven polypropylene. The most common materials are spunbond, meltblown, and spunlace [1].

Surface activation and alteration of textiles have been achieved via plasma therapy. Plasma modifies the surface of the substrate material by ionised, highly reactive species such as ions, electrons, and radicals, and the composition of plasma varies depending on the gas employed. Plasma technology is a resource-efficient and environmentally beneficial method. Plasma treatment has long been regarded as an environmentally friendly alternative to traditional wet textile coating and finishing procedures. Sterilization, wettability and hydrophobicity, dyeability increase, flame-retardant finishing, and antibacterial qualities are some of the textile applications of plasma. Plasma surface modification of fibres is a means to add value to a nonwoven fabric and improve the final product's functional performance. The application areas of polypropylene nonwovens are expanded by plasma treatment. Polypropylene fibres can be modified on the surface in terms of physical and chemical structures, allowing them to be used in a variety of applications such as coating, medicinal, apparel, filtering, laminating, dyeing, printing, and so on. We found plasma treated Polypropylene nonwoven treated with oxygen gas plasma improving the dynamic water absorption properties in which fiber fineness place a role for giving antimicrobial finish to the layer of mask [2].

The creation of a universal, antiviral, antibacterial material that may be dipped or sprayed onto fabric to provide an antibacterial coating. The fabric of a non-woven mask can be treated with an antibacterial coating to make it more effective. The market for face masks is expected to expand from USD 0.9 billion in 2019 to USD 21.5 billion in 2021, before declining to USD 2.7 billion by 2026. The projected CAGRs for these periods are 381.8% between 2019 to 2021 and an overall CAGR of -33.7% from 2021 to 2026. The breakout of the COVID-19 pandemic, increased consumer knowledge of the significance of face masks, and a boom in social media marketing to create a positive attitude about wearing masks are the key factors driving the growth of the face mask market. Mask production needs to be boosted by 40% to fulfil worldwide demand, according to the World Health Organization. As the pandemic spreads to more than 213 nations, governments around the world are limiting mask exports in order to meet domestic demand by increasing manufacturing. In countries that rely on imports, this has resulted in shortages. As a result, numerous companies throughout the world are attempting to increase their manufacturing of face masks in order to fulfil the increased demand. As of early May 2020, 88 percent of the world's population lived in countries that either encouraged or required the use of masks in public; over 75 countries had legislated mask use. Many social media platforms have launched campaigns advocating the usage of face masks to foster a favorable attitude toward using them in the community in order to prevent the spread of the new coronavirus. For competitors in the face mask market, emerging markets such as India, Brazil, China, and South Africa provide considerable prospects. The need for improving healthcare services in

these countries is being driven by a rapidly growing older population, high patient volumes, rising per capita income, and increased awareness. This has presented manufacturers with enormous potential for expansion [5].

Nonwoven materials with a high electric charge or those that may easily acquire charge had the maximum aerosol filtration effectiveness per unit of pressure drop, according to the findings of this study [3]. We will look at the current materials used in face masks and respirators, as well as prospective future advancements that will improve their protection against SARS-CoV-2, in this review. Cotton, natural silk, and chiffon were found to be more efficient than 50% in previous research. Furthermore, a cotton quilt with a highly tangled fibrous nature was discovered to provide excellent filtration in the small particle size range. The use of various filter materials on the filter surfaces, such as nanofibres, silver nanoparticles, and nano-webs, to induce antimicrobial characteristics is also described in depth.

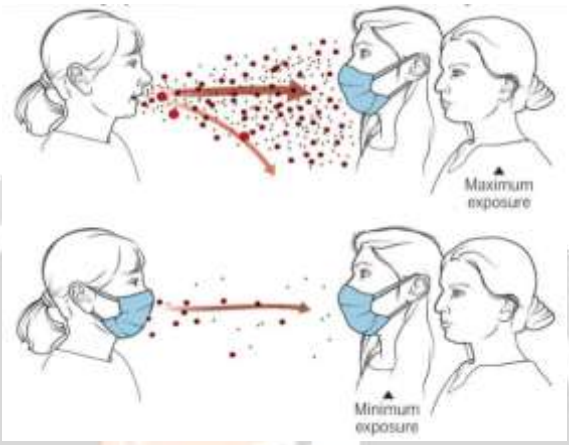

Figure1: Mask Exposure

The use of various technologies such as low-temperature plasma to modify N95/N99 masks to provide additional air filtration and destroy germs is discussed. There are also legislative guidelines for choosing and wearing facial protection. The possibility of reusing these masks will be investigated, as well as a discussion of mask modelling and the effects of wearing them. It is also explored how to employ Artificial Intelligence (AI) models and applications to decrease or prevent viral spread using face masks and respirators. The creation of highly efficient, reusable, anti-viral, and thermally regulated face masks and respirators will require a large amount of research, according to the findings [6].

2. MATERIALS REQUIRED:

- Non-woven Spun bond(hydrophobic)-50GSM
- Melt Blown -20 GSM
- Hot air cotton mesh -20 GSM
- Spun bond (hydrophilic) -25 GSM
- Antimicrobial solution (Blue silver)

2.1 Non-woven Spun bond polypropylene:

Polypropylene is a multi-variety plastic with the added distinction of being one of the least harmful to the environment. Because of its inert qualities and environmentally favourable features, Polypropylene is one type of polymer that is gaining appeal across industries. Spunbond is a term for spun laid. A continuous process of fibres being spun and directly dispersed into a web-like structure, or air streams can be guided, is used to create nonwoven fabric. As a result of this procedure, the belt speed increases [11].

2.2 Non-woven Melt Blown polypropylene:

Polypropylene or PP Melt blown Nonwoven Fabric is manufactured of Polypropylene and has a fibre diameter of 1 to 5 microns. It performs well in terms of oil absorption, thermal insulation, filtration, and shielding. For PP Melt blown nonwoven fabric, you can get various anti-wrinkle fluffy architectures and avoids. Melt blown polypropylene is used as the middle layer in several certified medical masks and respirators, such as N95s, because it filters exceedingly well [11].

2.3 Hot Air Cotton Mesh:

Tuyere cotton, commonly known as hot air cotton, is a new type of thermal insulator. Spray cotton is not the same as hot air cotton. Its fixing method is to mix a particular amount of low-melting fibre or ES two-component fibre with the raw materials rather than using latex. N95 masks use a type of filler material called hot air cotton non-woven fabric. Some producers utilise hot air cotton non-woven fabric with high bulkiness, good flexibility, soft feel, powerful warmth, and good air permeability to balance the effect of warmth and protection. Hot air cotton, also known as air vent cotton, is a novel form of insulating material that is made of spray adhesive cotton and looks like silk [12].

2.4 Antimicrobial solution (Blue silver):

Silver ion antimicrobial technology is a silver-based active ingredient that can be introduced into polymers, coatings, textiles, and other products to provide continuous antimicrobial protection. Silver or silver compounds' antibacterial activity is proportional to the amount of bioactive silver ion (Ag (+) released and its ability to interact with bacterial or fungal cell membranes. Silver-based surface coatings are a popular use. involves creating a vapor that activates a silver-containing hydrophilic surface coating when the container is opened, allowing the medical apparatus to sterilize itself. Silver's antimicrobial characteristics have long been prized in medical applications, with implanted equipment being coated with silver nanoparticles for antimicrobial protection. Many of the antimicrobial compounds used in fabrics are completely safe. Antimicrobial fabrics, according to some specialists, may help protect you from COVID-19, as some research suggest [7].

3. Testing and Treatment:

3.1 Plasma Treatment:

Textiles are treated with plasma to increase their wet ability, allowing solvent-free colors to soak and adhere nicely. Plasma therapies aim to convert low-energy surfaces to higher-energy surfaces by removing hydrogen from the surface and replacing it with oxygen-containing molecules. Other 'functional groups' can be formed on the surface, resulting in a wide range of distinct characteristics. Polypropylene nonwovens are used in a variety of applications, such as an absorbable dressing material in medical textiles, as well as cushioning and comfort in compression bandages. Polypropylene, on the other hand, has a very low surface free energy, resulting in poor hydrophilic characteristics. Plasma appears to be one of the most promising and cost-effective solutions to these problems. Plasma treatment of polypropylene has a significant impact on surface morphology and fabric wettability, resulting in a rise in polypropylene surface energy and confirming the existence of polar groups on the surface with a reduction in contact angle [2].

3.4 Dip and Dry Method:

Dip coating is a simple, low-cost, dependable, and repeatable process that involves immersing the substrate in a solution containing hydrolysable metal compounds (or quickly produced particles) and withdrawing the substrate at a steady pace into a water-vapor atmosphere**.** By the same we are going to do the dip coating method to our fabric through the antimicrobial solution blue silver.

. **3.5.1 Bacterial filter efficiency test:**

The Bacterial Filtration Efficiency (BFE) test is done on filtration materials and devices, such as face masks, surgical gowns, hats, and air filters, that are designed to give protection against biological aerosols. The Bacterial Filtration Effectiveness test compares bacterial control counts to test article effluent counts to assess filtration efficiency. The challenge organism used in the test is Staphylococcus aureus. A liquid suspension of Staphylococcus aureus is aerosolized and given to the filter media at a constant flow rate of 28.3 liters per minute (LPM) or 1 cubic foot per minute after the filtration media has been preconditioned (CFM) [13].

3.5.2 Splash resistance test:

Nelson Labs offers two synthetic blood resistance tests to measure a product's ability to act as a barrier to blood-borne pathogens the Synthetic Blood Penetration – Splash Resistance test. A predetermined volume of synthetic blood is directed at high velocity at the center of the mask in the Splash Resistance test method, which puts medical face masks to the test. The resistance of the mask to being penetrated by synthetic blood under pressure is measured in splash resistance (mmHg). It assesses a mask's material construction's capacity to prevent fluids from passing through and potentially coming into touch with the wearer. splash resistance, also

known as drag, is the force that a fluid exerts on a moving object in the opposite direction of the movement. Drag is the force exerted by a fluid to prevent an object from moving through it [10].

3.5.3 Flammability Test:

The Medical Masks Flammability Tester is used to determine whether or not medical masks are flammable, ensuring that masks are safe to wear. The burner burns the specimen automatically, with customizable ignition time; after-flame and afterglow times are automatically timed and displayed on the display. The control panel has a user-friendly design with a touch screen for easy operation, and the test results are presented on the screen following the vertical flammability test. A draft-free stainless steel flammability chamber is included, as well as an observation glass for simple test viewing. human-head-shaped. The test standard must be defined for specimen mask holders, burners, and other associated gear [14].

3.5.4 Breathability test:

Mask breathability is a metric that quantifies how breathable a mask is in terms of breathing resistance. Breathing resistance is higher in masks that are the most difficult to breathe through. Two forms of breathing resistance, inhalation resistance and exhalation resistance, are measured according to NIOSH requirements for masks and respirators, and the findings are displayed as pressure drops over the mask in millimeters of water [9].

3.5.5 Durability Test:

Medical masks are widely used around the world by medical personnel in hospitals during procedures and interaction with patients, as well as by the general population who use them as face masks to avoid contamination during illness. Testing the strength of the mask ties is a vital aspect in ensuring that the medical masks are safe to use and that contamination is prevented. Contamination is more likely to occur if the ties break during use. If the ties break when applying the mask, it will be useless and money will be wasted. Testing the physical strength of the medical mask's ties in line with standards such as GB / T19083-2010 will verify that the ties can withstand the force applied when applying the mask, as well as the constant force added while the mask is in use [9].

3.5.6 Air permeability test:

This air permeability tester measures air permeability of textile fabrics such as clothing and industrial fabrics, technical, down proof, nonwovens, filters, paper, felts, tents, foam materials and other types. The tested sample is put in a channel with a specified cross-sectional area, and a specific air flow generates a pressure difference between the upper and lower sides of the test sample during the air permeability test. The test program may calculate the air flow through the fabric based on the cross-sectional area of the pressure differential to determine the fabric's air permeability [9].

4. Conclusion:

The global population has been compelled to adapt new ways of life as a result of the COVID-19 pandemic, including the adoption of masks as a new norm. As a result, this project gives a comprehensive overview of face masks, from public health to material development. The filtration efficiency of the nowadays mask is not constant, because the particles have completely different sizes, shapes, and properties. Therefore, we have to decrease the penetration by increase the filtration efficiency of our mask at any conditions. The relevance of wearing a mask in avoiding the transmission of airborne and droplet-borne illnesses was emphasized. The mechanism of protection, manufacturing, and performance testing of commercial masks were then discussed. As a result of plasma treatment, the observance of fabric is increased.

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