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An Innovative approach for design and development of antiviral face mask

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Abstract:
In recent times, India is facing an unprecedented growth of virus attacks, example COVID19, pollution related health disorders, damage due to microorganisms and fungi which is causing serious ecological imbalance and environmental degradation. This rapid spread of corona virus among people has created national lockdown and whole nation is affected due to damage created by corona virus.This rapid population growth along with the high rate of urbanization as well as industrialization and an increase in transport has resulted in an increase in the levels of various air pollutants like Oxides of Sulphur(SOx), Oxides of Nitrogen(NOx), Suspended Particulate Matter, Carbon Monoxide, Lead, Ozone, Benzene, and Hydrocarbons.
Maharashtra, in terms of virus affected population, was ranked first among the most polluted cities in the world. With respect to air pollution an annual average level of suspended particulate matter increased to 450µg/m3, which is nearly three times the National Ambient Air Quality Standard of 140 for residential areas. As a result of increase in pollution due to virus it has led to serious respiratory and other health problems and may sometime be fatal. In order to protect the people from health hazards caused by these pollutants, it has been found necessary to develop antiviral face mask which can protect the humans against these respiratory and health issues.
The Commercially available face masks are capable to protect the people against these issues but still it prevails from certain drawbacks and limitations against filtration efficiency especially bacterial filtration efficiency and particulate matters. The draw backs associated with commercial face masks are price, fit and their efficiency in filtrations.
Our major objective is to develop an antiviral face mask which has both viral, bacterial, fungal and particulate matter filtration at lower cost. A New attempt has been made by developing a triple layer fabric for efficient filtration purpose. The combination of fabrics that were used is spun bonded polypropylene and melt blown polyester fabric. Nano particle sized hyroxychloroquine/silver/zincoxide/ composite coating will be given to the intermediate layer fabric of the mask. So effective protection of the people against viral attacks is expected. And many of the commercially available product does not focus on the bacterial filtration efficiency, hence this feature of the developed face mask gives an added advantage and feather in the market.

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I. Introduction

Nearly one half of all Americans—an estimated 150 million—live in areas that don't meet federal air quality standards. The health risks of air pollution are extremely serious. Poor air quality increases respiratory ailments like asthma and bronchitis, heightens the risk of life-threatening conditions like cancer, and burdens our health care system with substantial medical costs. Particulate matter is singlehandedly responsible for up to 30,000 premature deaths each year.

Passenger vehicles are a major pollution contributor, producing significant amounts of nitrogen oxides, carbon monoxide, and other pollution. In 2013, transportation contributed more than half of the carbon monoxide and nitrogen oxides, and almost a quarter of the hydrocarbons emitted into our air. Research shows that motor vehicles are responsible for about 70% of south-east Queensland's air pollution. Unless we all start reducing car use and motor vehicle pollution, this level is set to increase dramatically.

The people of Delhi still have memories of the Bhopal disaster. The Bhopal Gas was caused by an acute exposure to methyl-isocyanate (MIC) leaking from the Union Carbide pesticide plant and killed about

2000 people. This disaster is a tragic illustration of the impact of pollutants on human health. The health effects of pollutants depend upon the concentration, exposure duration and the individual's susceptibility. In general, after an initial lag period the health effects become manifest and continue to rise, reaching a plateau thereafter. There are important connections between air pollution and diseases, and the cost that they impose on the society. A positive, significant relationship between particulate pollution and daily non-traumatic deaths as well as deaths from certain causes (respiratory and cardiovascular problems) and for certain age groups. In general, these impacts are smaller than those estimated for other countries, where on an average a 100-microgram increase in total suspended particulates (TSP) leads to a 6% increase in non-traumatic mortality. In Delhi, such an increase in TSP is associated with a 2.3% increase in deaths. The differences in magnitudes of the effects are most likely explained by differences in distributions of age at death and cause of death, as most deaths in Delhi occur before the age of 65 and are not attributed to causes with a strong association with air pollution. Although air pollution seems to have less impact on mortality counts in Delhi, the number of life years saved per death avoided is greater in Delhi than in U.S. cities-because the age distribution of impacts in these two places varies. In the United States particulates have the greatest influence on daily deaths among persons 65 and older. In Delhi, they have the greatest impact in the 15 to 44 age group. That means that for each death associated with air pollution, on average more life-years would be saved in Delhi than in the United States. Large differences in the magnitude of effects do call into question the validity of the "concentration-response transfer" procedure. In that procedure, concentration-response relationships found for industrial countries are applied tocities in developing countries with littleor no adjustment, to estimate the effects ofpollution on daily mortality. The World Health Report attributes environmental risks especially the urban air pollution, indoor air pollution, lead exposure and climate change as some of the causes for the Disability Adjusted Life Year. (DALY).

With the multi-pronged efforts taken by the Delhi Government in recent years as already mentioned, the concentration of both SO2 and CO have declined. However, the impact of introduction of CNG on the levels of NOX, SPM and RSPM needs to be studied in detail. No specific epidemiological study on impact of air pollution and its effects on human health has been done in Delhi. More importantly, cost effective solutions need also to be developed through advanced research and analysis and integrated into the policy framework in various sectors like transport, health and even the industrial policy. This has not happened so far.

Research on virus nanoparticles has provided cues to the regulation of cytoplasmic transport. Viruses that replicate their genomes in the nucleus make use of the microtubule and the actin cytoskeleton as molecular motors for trafficking toward the nuclear membrane during entry and the periphery during egress after replication. Analyzing the underlying principles of viral cytosolic transport will be helpful in the design of viral vectors to be used in research as well as human gene therapy, and in the identification of new antiviral target molecules.

Scanning surface confocal microscopy, simultaneous recording of high-resolution topography and cell surface fluorescence in a single scan enables imaging of individual fluorescent particles in the nanometer range on fixed or live cells. This technique has been used to record the interaction of single virus-like particles with the cell surface and demonstrated that single particles sink into the membrane in invaginations reminiscent of pinocytic vesicles (Gorelik et al 2002). This method provides a technique for elucidating the interaction of individual viruses and other nanoparticles, such as gene therapy vectors, with target cells.

Silver nanoparticles undergo a size-dependent interaction with HIV-1 and particles in the range of 1–10 nm attached to the virus (Elechiguerra et al 2005). The regular spatial arrangement of the attached nanoparticles, the center-to-center distance between nanoparticles, and the fact that the exposed sulfur-bearing residues of the glycoprotein knobs would be attractive sites for nanoparticle interaction suggest that silver nanoparticles interact with the HIV-1 virus via preferential binding to the gp12 glycoprotein knobs. Due to this interaction, silver nanoparticles inhibit the virus from binding to host cells, as demonstrated in vitro.

II. Features of the product / system proposed to be taken up for development.

Antiviral face mask will be developed by us which will be capable of protecting the people from viral infections and in turn this mask will be antibacterial in nature and also this will bridge the gap by providing a solution for protecting human beings from COVID 19 and also from other viral infections in future.

The main objective is to design and develop an antiviral face mask that would be capable of protecting the individual wearing the mask against viruses, microorganisms, fungal infections, smokes, fumes, polluted gases, airborne particles, viz. nanohyrodyxchloro/silver/zinc oxide coated fabrics, used for formation of mask. This is really necessary to investigate the effect of reaction of these nano coated chemical particles with the polymeric structure of the fabrics. The effective interaction of these nano size chemical particles in the material site will act as a barrier against the attack of the viruses. This is an area which demand is higher at present having greater demand to protect people against COVID19.

A New attempt has been made by developing a triple layer fabric for efficient filtration purpose. The combination of fabrics that were used is spun bonded polypropylene with melt blown polyester fabric as a

sandwich layer. Nano particle sized hyroxychloroquin/zincoxide/silver coating will be given to the intermediate layer fabric of the mask. So effective protection of the people against viral attacks is expected. And many of the commercially available product does not focus on the bacterial filtration efficiency, hence this feature of the developed face mask gives an added advantage and feather in the market.

III. Materials:

For the production of Anti-Pollution Mask:

- OUTER LAYER – SPUNBOND POLYPROPYLENE FABRIC
- FILTRATION LAYER – MELT BLOWN POLYESTER FABRIC COATED WITH ZINC OXIDE+NANO SILVER+ HYDROXYCHLOROQUIN
- INNER LAYER – SPUNBOND POLYPROPYLENE FABRIC

3.1 NONWOVEN POLYPROPYLENE FABRIC

Technically (PP) Polypropylene is a plastic noted for its light weight, being less dense than water; it is a polymer of propylene. It resists moisture, oils, and solvents. Since its melting point is 121°C (250°F), it is used in the manufacture of objects that are sterilized in the course of their use. Polypropylene is also used to make textiles, ropes that float, packaging material, and luggage.

Since recent years, it tends to replace the traditional existing textiles, fabric and paper for some obvious reasons. The main asset of Nonwoven polypropylene (P.P.) fabric is that it is made of spun bond polypropylene which can be recycled, naturally decomposes (untreated nonwoven fabric can decompose in the outside within a few months only..) and completely incinerates without any production of poisonous pollutants (does not pollute directly or indirectly the environment. It does not contain any harmful substances itself and does not require the use of poisonous gas, wasted oil or effluents.

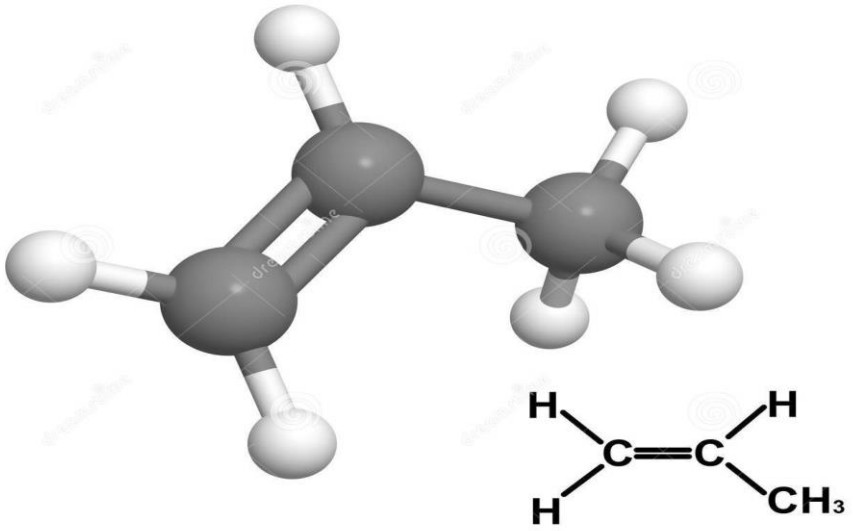

Fig 1: Structure of polypropylene

It is a polymer of ethylene, and is produced at high pressures and temperatures in the presence of any one of several catalysts, depending on the desired properties for the finished product, Eco friendlyP.P. can go a long way for the concept of environmentally friendly products and can be expanded when you choose to use nonwoven P.P.fabric.Nonwoven fabrics got environmental benefits over other traditional fabrics and papers in regards to mainly its production process and its recycling benefits due to natural degrading properties and the recycle process for its production. Cheap, Nonwoven is very competitive with other fabrics (often cheaper than paper or plastic bag) and is very durable with all the attribute of woven fabrics as mentioned above (softness, air permeability, dehumidifying, cushioning, resilience, good light weight, ability to repel water and to evaporate water, resistance to mould and insect., etc..)

Various add –on treatment can be added to the PP fabric such as:

- -Flame Retardency (for Airplanes, Hotels designated products)
- -Antibacterial (medical use products)
- -Florescent treatment (caution, promotion and advertising items)
- -Compounded treatments (adding layers of others fabric for various purpose such as Aluminium film, PE film, Eva film, PVC, Absorbent paper, CPP film.. etc..)

- -Anti Mildew treatment (storage purpose)
- -Lamination treatment for offset printing, Etc.

Fig 2: Polypropylene fabrics

3.2 MELT BLOWN POLYESTER FABRIC:

3.2.1 Meltblown Polyester Nonwoven Fabric Market: Overview

Melt blowing is a technique used for the manufacture of thin sheets of nonwoven fibers. It is a method by which polymer melt is extruded out through tiny nozzles and subjected to high-speed blowing gas. Due to presence of gas, the extruded polymer forms a nonwoven polymer sheet. Different polymers are used as raw materials in the process of melt blowing. The process starts with a polymer resin and ends with a finished, self-bonded fabric with superior properties.

Some of the commonly used polymers include polypropylene, polyesters, polyamides, and polystyrenes. The fibers obtained are ultra-fine in nature compared to the fibers obtained by any other manufacturing process such as spun bound. The filaments obtained by this technique are generally of the size of 2–5 microns. However, by modification, the size can be reduced up to 1 micron even. Due to the fine size of filaments, the nonwoven fabric obtained is soft and durable. Meltblown fabrics are known to have high insulating properties and good barrier properties, which makes them useful in a variety of applications.

3.2.2 **Meltblown Polyester Nonwoven Fabric Market: Trends**

Meltblown fabrics have special properties such as absorbency, thermal insulation, cushioning, wash-ability, strength, sterility, liquid repellence, and bacterial barrier. Meltblown polyester nonwoven fabrics are used in products required for maintaining the hygiene such as hair caps, filters, wiping cloths, and masks. One of the leading fields of application of meltblown polyester nonwoven fabrics is disposable diapers and feminine care products.

Exclusive properties of meltblown polyester nonwoven fabrics coupled with their low cost are expected to drive the market in the next few years. These fibers can be manufactured in such a way such that they can function as a woven fabric. Meltblown polyester nonwoven fabrics are used in combination with or as a component of home furnishings, apparels, engineering materials, and health care, industrial as well as consumer goods.

The market for meltblown polyester nonwoven fabrics is expected to witness significant growth during the forecast period, primarily due to increased demand for these fabrics in absorbent hygiene products such as baby diapers and feminine care products.

Meltblown polyester nonwoven fabric is expensive compared to spunbond polyester nonwoven fabric, due the usage of compressed air that consumes a large amount of energy. Due to high manufacturing costs associated with meltdown process, spunbond polyester nonwoven fabrics are more preferred, which could be a potential restraint for the market for meltblown polyester nonwoven fabrics in the near future.

3.2.3HEPA H11 Polyester MeltblownNon Woven Fabric HDF90-H11

Hepa H11 Polyester meltblownnon woven fabric is a high-performance non-woven sheet made of special ultra-fine polypropylene fibers. The polypropylene fibers are given electronic properties through a specialized process. It is an indispensable material for air purifiers, air filters, masks, hair caps and wiping cloths.

3.2.4 **The Features of HEPA H11 Polyester MeltblownNon Woven Fabric**

1.Melt-blown non-woven fabrics are finding more and more applications in the industry and society in general.

2.Due to its unique characteristics, melt-blown non-woven fabrics are especially popular for medical use and in filters. This is primarily due to its ability to produce microfibers.

3.Melt-blown microfibers have diameters ranging from 2 to 4 microns, although they may be as small as 0.1 micron or as large as 10 or 15 microns.

4.These microfibers can prove to be beneficial for melt-blown fabrics in the parameters of softness, cover, porosity and rigidity.

3.3**Antibacterial Activity of Zinc oxide**

Bacteria are generally characterized by a cell membrane, cell wall, and cytoplasm. The cell wall lies outside the cell membrane and is composed mostly of a homogeneous peptidoglycan layer (which consists of amino acids and sugars). The cell wall maintains the osmotic pressure of the cytoplasm as well the characteristic cell shape. Gram- positive bacteria have one cytoplasmic membrane with multilayer of peptidoglycan polymer, and a thicker cell wall (20–80 nm). Whereas gram-negative bacteria wall is composed of two cell membranes, an outer membrane and a plasma membrane with a thin layer of peptidoglycan with a thickness of 7–8 nm. NPs size within such ranges can readily pass through the peptidoglycan and hence are highly susceptible to damage. The cytoplasm, a jelly-like fluid that fills a cell, involves all the cellular components except the nucleus. The functions of this organelle include growth, metabolism, and replication. Consequently, the cytoplasm contains proteins, carbohydrates, nucleic acids, salts, ions, and water (*80 %). This composition contributes in the electrical conductivity of the cellular structure. The overall charge of bacterial cell walls is negative. Figure 1b shows typical bacteria cell structure. Antibacterial activity is known according to The American Heritage Medical Dictionary 2007, as the action by which bacterial growth is destroyed or inhibited. It is also described as a function of the surface area in contact with the microorganisms. While antibacterial agents are selective concentration drugs capable to damage or inhibit bacterial growth and they are not harmful to the host. These compounds act as chemo-therapeutic agents for the treatment or prevention of bacterial infections (Saunders Comprehensive Veterinary Dictionary).

IV. Role of Nano technologyin treatment of viruses

Infectious diseases are the leading cause of mortality worldwide, with viruses in particular making global impact on healthcare and socioeconomic development. In addition, the rapid development of drug resistance to currently available therapies and adverse side effects due to prolonged use is a serious public health concern. The development of novel treatment strategies is therefore required. The interaction of nanostructures with microorganisms is fast-revolutionizing the biomedical field by offering advantages in both diagnostic and therapeutic applications. Nanoparticles offer unique physical properties that have associated benefits for drug delivery. These are predominantly due to the particle size (which affects bioavailability and circulation time), large surface area to volume ratio (enhanced solubility compared to larger particles), tunable surface charge of the particle with the possibility of encapsulation, and large drug payloads that can be accommodated. These properties, which are unlike bulk materials of the same compositions, make nanoparticulate drug delivery systems ideal candidates to explore in order to achieve and/or improve therapeutic effects. This review presents a broad overview of the application of nanosized materials for the treatment of common viral infections.

4.1**Organic nanoparticles:**

Organic nanoparticles are the most extensively researched type of nanoparticle for drug delivery and the most widely approved system for therapeutic use in humans. The most common types of organic nanoparticles are presented as follows. Polymeric nanoparticles. Polymeric nanoparticles are colloidal solids with sizes ranging from 10 to 1000nm. The small size can facilitate capillary penetration and uptake by cells resulting in increased concentrations at target sites. Polymers approved by the World Health Organization (WHO) and the Food and Drug Administration (FDA) for use in medicine and pharmaceuticals include polylactides (PLA), polyglycolides (PGA) and poly(lactide-co-glycolides) (PLGA).Poly(D,L-lactide-co-glycolide) (PLG) and PLGA-based nanoparticles are most widely used due to their superior biocompatibility and biodegradability profiles. Surface modifications with hydrophilic polymers such as PEG are essential to reduce non-specific interactions with serum proteins, decrease susceptibility to opsonization and to defer uptake by phagocytosis, thereby prolonging the drug half-life and further altering the biodistribution and pharmacokinetic profile of the drug,54 and has thus been considered as the ‘gold-standard’ of cloaking agent systems.

4.2 **Silver nanoparticles.**

Silver nanoparticles are the most effective of the metallic nanoparticles against bacteria, viruses and other eukaryotic microorganisms,88 particularly due to the inherent inhibitory and bactericidal potential of silver, but also because of their good conductivity, catalytic properties, and chemical stability. The key mechanisms of action of silver nanoparticles are the release of silver ions (which enhances antimicrobial

activity), cell membrane disruption, and DNA damage. The reader is referred to a detailed review on the application of silver nanoparticles as virucidal agents.

4.3 **Hydroxychloroquinin and it's effects**

Recently, a novel coronavirus (2019-nCoV), officially known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), emerged in China. Despite drastic containment measures, the spread of this virus is ongoing. SARS-CoV-2 is the aetiological agent of coronavirus disease 2019 (COVID-19) characterised by pulmonary infection in humans. The efforts of international health authorities have since focused on rapid diagnosis and isolation of patients as well as the search for therapies able to counter the most severe effects of the disease. In the absence of a known efficient therapy and because of the situation of a publichealth emergency, it made sense to investigate the possible effect of chloroquine/hydroxychloroquine against SARS-CoV-2 since this molecule was previously described as a potent inhibitor of most coronaviruses, including SARS-CoV-1. Preliminary trials of chloroquine repurposing in the treatment of COVID19 in China have been encouraging, leading to several new trials.

Chloroquine is an amine acidotropic form of quinine that was synthesised in Germany by Bayer in 1934 and emerged approximately 70 years ago as an effective substitute for natural quinine. Quinine is a compound found in the bark of Cinchona trees native to Peru and was the previous drug of choice against malaria. For decades, chloroquine was a front-line drug for the treatment and prophylaxis of malaria and is one of the most prescribed drugs worldwide. Chloroquine and the 4-aminoquinoline drug hydroxychloroquine belong to the same molecular family. Hydroxychloroquine differs from chloroquine by the presence of a hydroxyl group at the end of the side chain: the N-ethyl substituent is βhydroxylated. This molecule is available for oral administration in the form of hydroxychloroquine sulfate. Hydroxychloroquine has pharmacokinetics similar to that of chloroquine, with rapid gastrointestinal absorption and renal elimination

However, the clinical indications and toxic doses of these drugs slightly differ. In malaria, the indication for chloroquine was a high dose for a short period of time (due to its toxicity at high doses) or a low dose for a long period of time. Hydroxychloroquine was reported to be as active as chloroquine against Plasmodium falciparum malaria and less toxic, but it is much less active than chloroquine against chloroquine-resistant P. falciparum owing to its physicochemical properties. What is advantageous with hydroxychloroquine is that it can be used in high doses for long periods with very good tolerance. Unfortunately, the efficacy of chloroquine gradually declined due to the continuous emergence of chloroquine-resistant P. falciparum strains. Chloroquine is also utilised in the treatment of autoimmune diseases. Yet the activity of the molecule is not limited to malaria and the control of inflammatory processes, as illustrated by its broad-spectrum activity against a range of bacterial, fungal and viral infections. Indeed, in the mid-1990s, due to its tolerability, rare toxicity reports, inexpensive cost and immunomodulatory properties, chloroquine repurposing was explored against human immunodeficiency virus (HIV) and other viruses associated with inflammation and was found to be efficient in inhibiting their replication cycle.

4.4 **Antiviral properties of chloroquine**

In vitro, chloroquine appears as a versatile bioactive agent reported to possess antiviral activity against RNA viruses as diverse as rabies virus , poliovirus , HIV , hepatitis A virus hepatitis C virus , influenza A and B viruses, influenza A H5N1 virus,Chikungunya virus, Dengue virus, Zika virus , Lassa virus,Hendra and Nipah viruses , Crimean–Congo hemorrhagic fever virus and Ebola virus , as well as various DNA viruses such as hepatitis B virus and herpes simplex virus.The antiviral properties of chloroquine described in vitro have sometimes been confirmed during treatment of virus-infected patients but have not always been reproduced in clinical trials depending on the disease, the concentration of chloroquine used, the duration of treatment and the clinical team in charge of the trial. Regarding coronaviruses, the potential therapeutic benefits of chloroquine were notably reported for SARS-CoV-1. Chloroquine was also reported to inhibit in vitro the replication of HCoV229E in epithelial lung cell cultures. In 2009, it was reported that lethal infections of newborn mice with the HCoV-O43 coronavirus could be averted by administering chloroquine through the mother's milk. In vitro experiments also showed a strong antiviral effect of chloroquine on a recombinant HCoV-O43 coronavirus. Although chloroquine was reported to be active against Middle East respiratory syndrome coronavirus (MERS-CoV) in vitro, this observation remains controversial.

4.4.1 Potential antiviral effect of chloroquine against SARS-CoV-2

Because of its broad spectrum of action against viruses, including most coronaviruses and particularly its close relative SARSCoV-1, and because coronavirus cell entry occurs through the endolysosomal pathway, it made sense in a situation of a publichealth emergency and the absence of any known efficient therapy to

investigate the possible effect of chloroquine against SARS-CoV2. A recent paper reported that both chloroquine and the antiviral drug remdesivir inhibited SARS-CoV-2 in vitro and suggested these drugs be assessed in human patients suffering from COVID-19. Recently, the China National Center for Biotechnology Development indicated that chloroquine is one of the three drugs with a promising profile against the new SARS-CoV-2 coronavirus that causes COVID-19. Chloroquine repurposing was investigated in hospitals in Beijing, in central China's Hunan Province and South China's Guangdong Province. According to preliminary reports from the Chinese authorities suggesting that approximately 100 infected patients treated with chloroquine experienced a more rapid decline in fever and improvement of lung computed tomography (CT) images and required a shorter time to recover compared with control groups, with no obvious serious adverse effects, the Chinese medical advisory board has suggested chloroquine inclusion in the SARS-CoV-2 treatment guidelines. As a result, chloroquine is probably the first molecule to be used in China and abroad on the front line for the treatment of severe SARSCoV-2 infections. Although the long use of this drug in malaria therapy demonstrates the safety of acute chloroquine administration to humans, one cannot ignore the minor risk of macular retinopathy, which depends on the cumulative dose, and the existence of some reports on cardiomyopathy as a severe adverse effect caused by chloroquine. A survey of SARS-CoV2-infected patients for adverse effects of chloroquine therapy remains to be performed. However, chloroquine is currently among the best available candidates to impact the severity of SARS-CoV-2 infections in humans. Currently, at least ten clinical trials are testing chloroquineas an anti-COVID-19 therapy.

4.5 **comparison of the system taken up for development with similar products if available in international market indicating similarities of differences.**

Anti pollution face masks and other surgical face masks are available in our society but they are also having good bacterial filtration efficiency but our product is nano particle coated anti viral face mask which will be capable to filter bacteria, fungi, microorganisms and mainly the nano particle coating will hinder the reaction of poisonous viruses like CORONA, HUNTA etc.

Organic nanoparticles are highly helpful to be converted into a nano-scale particle size distribution especially gold nano-particles and silver nano-particles. metallic nanoparticles like zinc, copper, titanium, etc.... could be utilised as a supporting material to enhance the efficacy of the antiviral drugs.

As stated nano-particle could be applied either in the form of spray or dip coating technologies and also it could be synthesized either by using top-down or bottom-up approaches.

So far hydroxychloroquine is used as an effective antiviral drugs for treating diseases like malaria, dengue, etc... But more than the beneficiary effects the side- effect created by this drug is still found challenging and also brought in some controversial reports. But still it is found to be an effective dose for treating covid-19 and SARS viruses but its reaction with the atmosphere virus has to be checked.

Moreover the coating could be applied in the middle layer if we develop a three layer composite as the outer layer leads to contamination and durability issues.

4.5.1 **Description of various techniques and novelty for choosing the particular technique of measurement.**

Anti pollution face masks and other surgical face masks are available in our society but they are also having good bacterial filtration efficiency but our product is nano particle coated anti viral face mask which will be capable to filter bacteria, fungi, microorganisms and mainly the nano particle coating will hinder the reaction of poisonous viruses like CORONA, HUNTA etc.

In addition to this we have already developed antipollution face mask which has the capability to filter out airborne particles, particulate matters, gases fumes and pollutant oxides from atmosphere but not having capacity to resist attacks from poisonous viruses like CORONA, HUNTA, SARS etc.

So our novelty in this proposal is to develop anti viral face mask by nano coated zinc oxide/hydroxychloroquinin/silver.

But silver is antimicrobial, antibacterial and antifungal in nature, and zinc oxide also is required for filtering airborne particles, particulate matters, gases fumes and pollutant oxides from atmosphere.

But using hydroxychloroquinin tablets will be reduced into nano size and mixed with zinc oxide and silver and formed as a composite paste on the intermediate fabric layer. We are having a plan to carry out the coating by including hydroxychloroquinin tablet as a new chemical, because we are eager to investigate the effect and interaction of this hydroxychloroquinin with virus and also we want to know how this chemical along with zinc oxide and silver will inhibit the penetration of virus.

V. Method of manufacturing

Experimental Methodlogy
Nano composite + Coating on to mask + drying + usage
Testing evaluation : in vitro testing with viruses

1. Bacterial filtration efficiency test
2. Air permeability
3. Pore size test
4. Reaction of atmospheric virus with the hydroxychloroquine
5. Breathing resistance test.
6. Subjective fit test analysis
7. Composite strength test

5.1 Composite synthesis :

Mix ZnOnano powder + silver nano powder + Hydroxychloroquin + water(minimum quantity) + mix well in a magnetic stirrer + dry at 40- 60^0 C to evaporate water.
Coating composite on a fabric layer:
Composite is taken in a container and water is introduced and stirred well and fabric is dipped to introduce nano powder coating on to the fabric layer. Dried the mask at 40-50^0C .
Bonding Mechanism.
nano composites powders will have good coating on fibres.
Nano powders are filled into fibre pores and also due to hydrophilic nature as attach to the OH group present in the fibre.

VI. Conclusion

1. Our major objective is to develop an antiviral face mask which has both viral, bacterial, fungal and particulate matter filtration at lower cost. A New attempt has been made by developing a triple layer fabric for efficient filtration purpose

2. This is really necessary to investigate the effect of reaction of these nano coated chemical particles with the polymeric structure of the fabrics. The effective interaction of these nano size chemical particles in the material site will act as a barrier against the attack of the viruses. This is an area which demand is higher at present having greater demand to protect people against COVID19.

3. Nano particle sized hyroxychloroquin/zincoxide/silver composite coating will be given to the intermediate layer fabric of the mask. So effective protection of the people against viral attacks is expected. And many of the commercially available product does not focus on the bacterial filtration efficiency, hence this feature of the developed face mask gives an added advantage and feather in the market.

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