An Additional Approach to Control the Spread of Covid-19 with Photocatalytic Disinfection by Nanocomposite Painting

M. M. Darade [1], D.V.Sawant [2], R.K.Sharma [3] and S.H.Pawar [4,1]

[1]Centre for interdisciplinary research D. Y. Patil education society deemed to be university, Kolhapur, Maharashtra. India
[2]Department of Microbiology Dr. D. Y. Patil Medical College Hospital and research institute, Kolhapur, Maharashtra
[3]D.Y. Patil Medical College, Kolhapur, Maharashtra, India

*Corresponding author.
milind.darade04@gmail.com

Abstract:

With all precautions taken suggested by WHO, the spread of Covid-19 is not yet controlled for last 20 months since December 2019. It is likely that the spread may be due to infection of SARS-CoV-2 existing on the surfaces at the public places. The existing technologies of antimicrobial coatings used in hospital may not be suitable, viable and economical to maintain at public placed. In this situation, an additional approach of visible light photocatalytic disinfection with nanocomposite painting is suggested and briefed in this paper.

1.Introduction:

The pandemic of coronavirus disease started in Dec. 2019 in china (COVID-19) is caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection. Now in August 2021 the disease is still spreading with devasting consequences in mortality and morbidity of human life, as well as affecting the global economy (1–4). According to the World Health Organization's (WHO) newly updated situation report on 5th October, 2021, the COVID19 pandemic has reached 235,175,106 confirmed cases and claimed 4,806,841 deaths, as documented globally in 228 countries worldwide (https://www.who.int/emergencies/ diseases/novelcoronavirus-2019). The disease is still being continued with all preventive measures taken. On 5th August, the cumulative number of COVID-19 cases globally surpassed 200 million, just six months after reaching 100

million cases. This week alone, over 4.2 million new cases and over 65 000 new deaths were reported, a slight increase as compared to the previous week. The largest proportionate increases in new cases were reported by the Region of the Americas (14%) and Western Pacific Region (19%), with 1.3 million and over 375 000 new cases reported, respectively. Additionally, a substantial increase (46%) in the number of new deaths was reported this week in the Western Pacific Region. Of the 228 Member States and territories, 38 (17%) reported more than a 50% increase in new cases as compared to the previous week and 34 (15%) reported a more than a 50% increase in new deaths. It means something is still missing to control the spread of COVID-19. In the present paper an attempt has been made to through some light on an additional precaution to be taken with an innovative approach to control the spread of COVID-19 by visible light photocatalytic disinfection with Nanocomposite painting on the surfaces of public / private places.

2. Nanoscience of SARS CoV-2 and its Delta Variants:

In order to understand the behaviour of SARS CoV-2, and its Interaction with biological cells, the scientists have studied its physical properties. The Scanning electron microscopic picture of SARS CoV-2 along with the attachment of biological cell is shown in figure.1

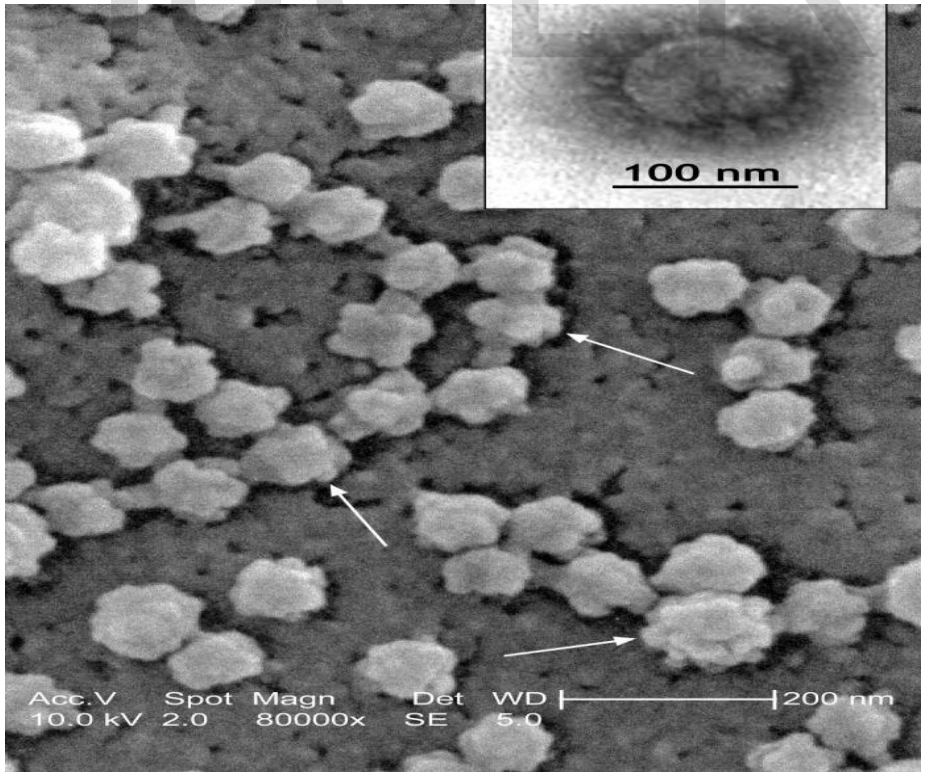

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Fig 1.: This Scanning electron microscope image shows SARS-COV-2 isolated from a patient, emerging from the surface of cell cultured in the lab. Image credit: en.wikipedia.org [5].

It is seen that the size of SARS CoV-2 is in the range of Nano meter. This reveals that SARS-CoV-2 is an example of Bio-Nano particle and its properties like electrical, optical, magnetic catalytic, and biological do change with the shape and size of nanoparticle. This alteration may be attributed to the variation of surface to volume ratio with the change in its diameter This is very well documented and published in the literature [6]. Since SARS-CoV-2 is hazardous to health, it is being destroyed by various ways and means. During the process of its destroying, it may happen that it is not destroyed completely and leave behind with its different shape and size. This may give rise to the different variants of SARS-CoV-2 and newer strains of COVID-19.

A newer strain of COVID-19 is causing concern as cases are rising in California and across the U.S. The Delta variant, which originated in India, began spreading more rapidly and making news around the middle of June. Now, health experts are warning of another surger of COVID-19. Here's what health experts have learned about the Delta variant:1. Delta variant is highly contagious,2. Delta variant symptoms are the same ,3. Delta variant is affecting unvaccinated people more, 4. Breakthrough cases for vaccinated people are rare, but do happen, 5. Delta variant could be catastrophic in some communities, 6.Many unvaccinated patients with COVID-19 wish they had gotten the vaccine, 7. Some experts are recommending to wear masks, even if you're fully vaccinated, 8. More COVID-19 variants are likely to come[9]. The Delta variant is currently the most prominent strain of COVID-19, but the Lambda variant out of South America is also emerging. Health experts urge that if people want to get back to normal, a significant portion of the population needs to be vaccinated. As long as a chunk of people across the world are unvaccinated, new strains of the virus will continue to develop and cause problems.

3.Formulation of SARS-CoV-2 Bio Nanoparticles:

SARS-CoV-2 enters the host cell through direct fusion of the viral envelope with the cell membrane or membrane fusion within the endosome following endocytosis. The RBD of the S protein binds to the human host cell receptors on the cell surface, allowing the virus to enter the

cell[10].Angiotensin-converting enzyme 2 (ACE2), which is widely expressed in cells of the lung, colon, liver, heart, vascular endothelium, testis, and kidney, is one of the primary receptors for SARS-CoV-2.Other host receptors and/or co-receptors that facilitate SARS-CoV-2 entrance into respiratory system cells have recently been discovered. Following RBD receptor contact, the S protein is proteolytically cleaved by numerous host proteases, including furin, TMPRSS2, and cathepsin B/L.

S protein is activated by proteolytic processing, which allows for viral-host membrane fusion and the release of viral RNA into the host cytoplasm. Viral RNA replicates its genetic material and assembles new viral particles in the cytoplasm, using the host and its own machinery. SARS-CoV-2 appears to have a very broad cell tropism. SARS-CoV-2 can infect intestinal epithelial cells and brain cells, in addition to type II alveolar epithelial cells and ciliated cells in the lungs, causing intestinal symptoms and brain inflammation.

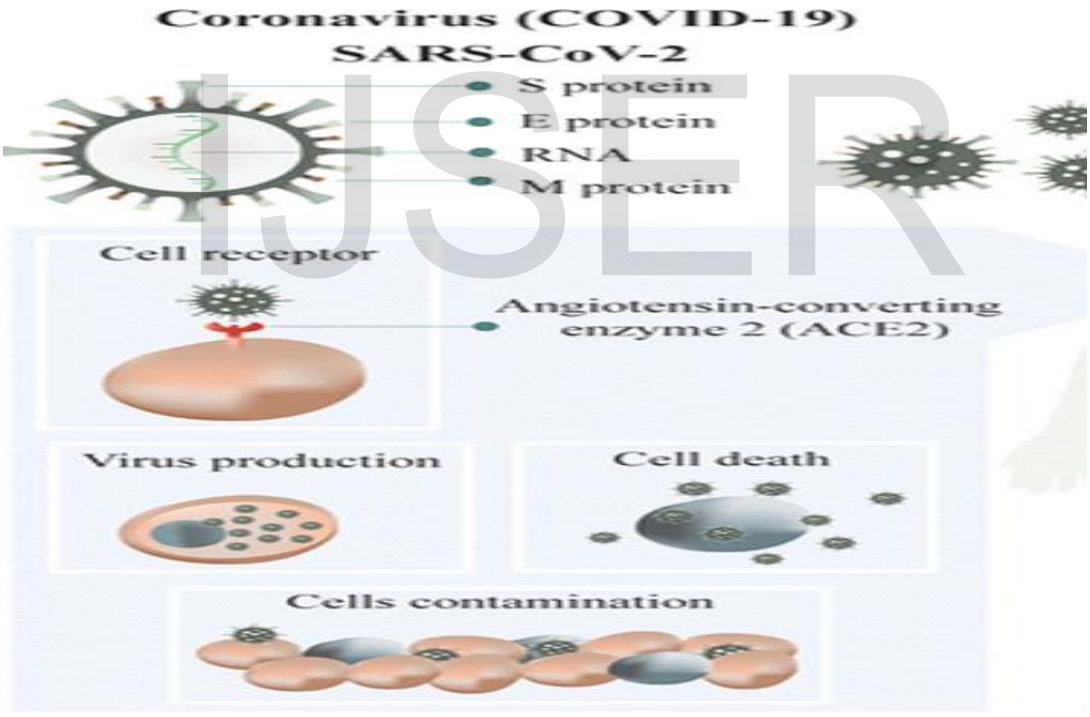

Fig 2. Schematic representation of SARS-CoV-2 reproduction [8].

4. Spread of SARS-CoV-2

SARS-CoV-2 is spread through fomites and droplets when infected and uninfected people come into close, unprotected contact. Following severe acute respiratory syndrome

coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus, the COVID-19 outbreak is the third novel acute infectious coronavirus disease to emerge in the last two decades (MERS-CoV), indicating that coronaviruses remain a powerful threat to public health. The persistence of SARS coronavirus 2 (SARS-CoV-2) RNA on surfaces in public places and hospitals, as well as on personal protective equipment (PPE), could be a source of infection transmission to the general public. Under normal settings, the RNA can last anywhere from a few hours to a few days. The presence of moderate SARS-CoV-2 protein content in respiratory droplets released by infected people while sneezing or coughing boosts the virus's chances of surviving on contaminated fomites' surfaces. Temperature, humidity, virus inoculum shed on inanimate surfaces, and the composition of the surface material all affect the virus's survival period on fomites. The bulk of a respiratory droplet carrying SARS-CoV-2 that falls on a surface evaporates, leaving behind a thin liquid layer containing the virus. On porous surfaces, the droplet evaporates faster than on impermeable ones. As a result, although porous materials hinder viral life, impermeable materials like glossy metallic surfaces, glass, and stainless steel are said to help SARS-CoV-2 survive. As a result, the contemporary coronavirus is spread not just by droplet spray but also through surfaces that might pass the virus from one person to the next. It's crucial to note that we're working on coatings that will work not only against the coronavirus, but also against other viruses and bacteria, as evidenced by our proof-of-concept trials, so they'll be useful in a variety of situations.

5. Conventional methods for the control of the spread of SARS-CoV-2

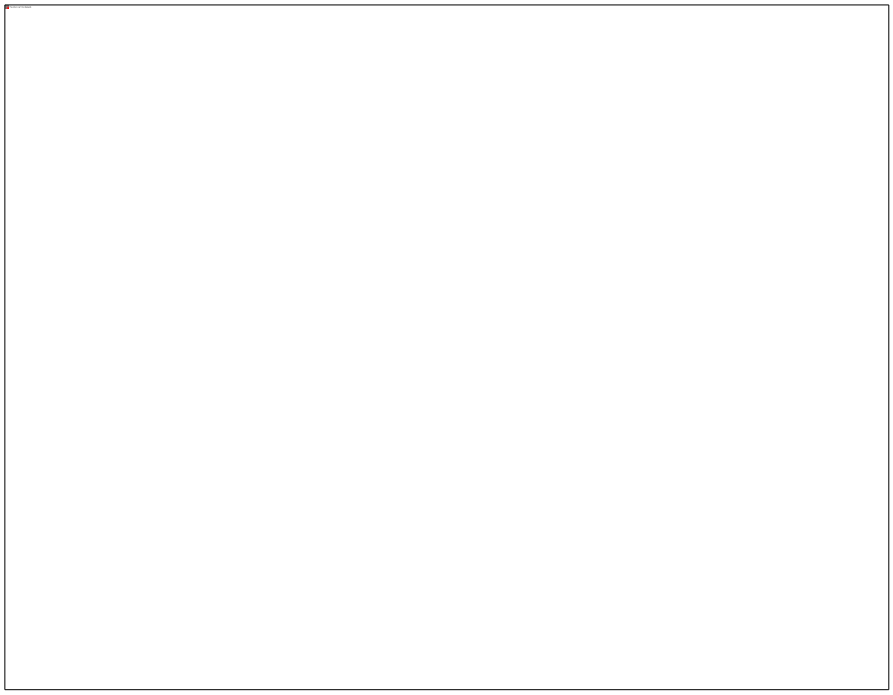

Fig 3. The figure shows the conventical control of SARS Cov-2 and Covid-19

The WHO has issued the instructions as shown in fig.3 above in order to protect from the spread of SARS-CoV-2 and control the Covid -19 disease: Vaccinate yourself, put on a mask, and keep at least 6 feet away from others. Avoid crowds and places with poor ventilation, and wash your hands frequently. Coughs and sneezes should be covered. Disinfect and clean Every day, keep an eye on your health this scamaticaly shown in figure 3[p].

6. Principle and Mechanism of Photocatalatic Disinfection

A photocatalytic material (semiconductor) is irradiated at a compatible wavelength (Energy equal to or greater than the bandgap of the semiconductor) in the process of photocatalysis (Fig.4).

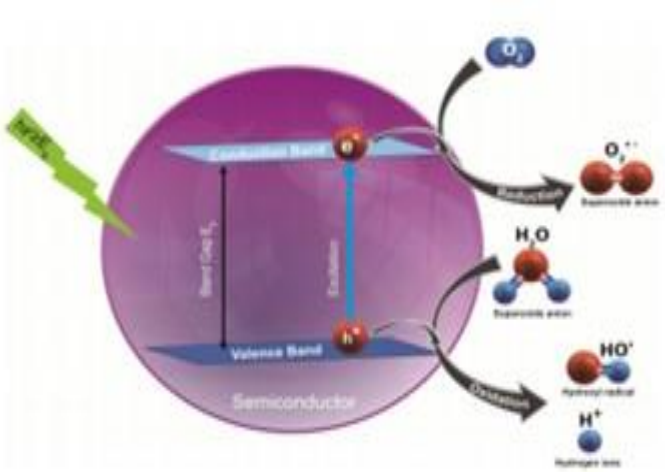

Figure 4. The fundamental mechanism of photo catalysis on a semiconductor particle surface.

The electrons (e) then elevate from the valence band (VB) and are absorbed onto the conduction band (CB), resulting in a positive electron–hole pair on the valence band (h VB). The excited electron–hole pair created in the VB and the positive electron–hole pair generated in the CB then travel toward the semiconductor's surface. At the same moment, oxidation and reduction reactions on the semiconductor's surface are complete.

Semiconductor excitation occurs by the bandgap illumination, leading to the creation of electrons(e^-) in the conduction band and holes (h+) in the valance band ($h\nu \geq E_g$[2] energy equal to or greater than the bandgap of semiconductor).

The electrons react with oxygen (O2) in the CB, resulting in the formation of superoxide radicals (O2) and hydroperoxide radicals (HO2). The contaminants (viral proteins, genome, and envelope) in the indoor air are photodegraded by the photocatalytic material in general. Antimicrobial photocatalysis can be utilised to disinfect air, water, and surfaces [7].

It has a number of benefits, including simultaneous disinfection of a variety of pathogens such as virus which is schematically shown below in figure 5.it is a low cost, and ease of use and maintenance.

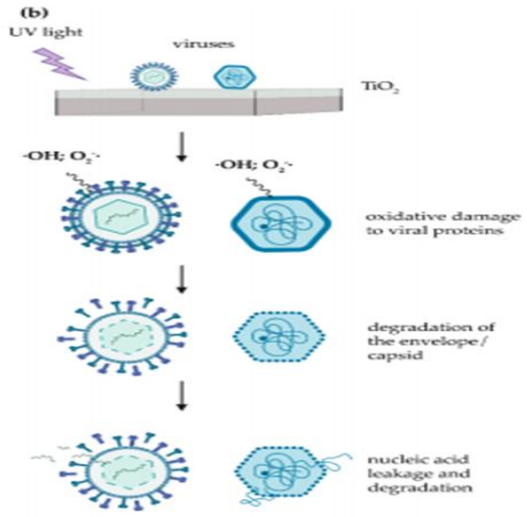

Fig 5. Mechanism of Photocatalytic inactivation of Viruses

7. An additional approach to control the spread of Covid-19:

At an individual and small scale levels the spread of SARS-CoV-2 is controlled by following the instructions as listed in fig.3. suggested by WHO. The antimicrobial coating helps to keep surfaces free of pathogens by limiting the growth of fungi, bacteria, and other parasites such as viruses. Antimicrobial coatings provide long-term protection from these illnesses while also helping to keep the environment clean. In order to reduce healthcare-associated illnesses, antimicrobial coatings are also used to sterilise medical devices such as catheters, urological instruments, and medical electronics. Despite taking all of the safeguards recommended by WHO, the spread of Covid-19 has remained unchecked for the past 20 months, from December 2019. The infection of SARS-CoV-2 found on surfaces in public locations is most likely to blame for the spread.

This work proposes and describes an additional strategy of visible light photocatalytic disinfection with nanocomposite painting in this situation. These coating must be sensitive to visible/solar light. Further, the coating must be applied in the form of painting so that it can be economically viable [12].

The Formulation of Nano composite TiO2 Based oil Paint Samples can be prepared by the percentile mixture of titanium dioxide nanomaterials (TiO2 powder) in the white coloured base oil paint with fraction of the turpentine to get homogenous mixture [13]. This is shown schematically in fig.6.

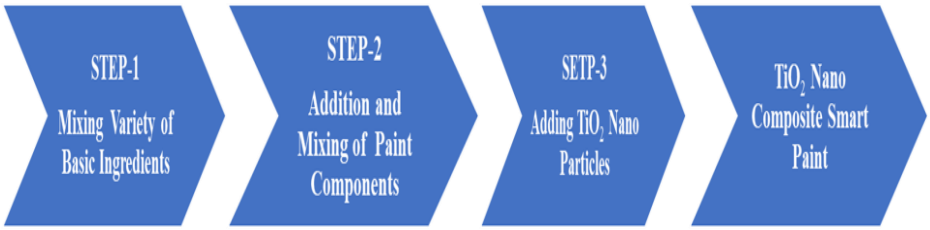

Fig 6: Preparation of NanoTio2 composite smart paint

Like wise the visible light sensitive photocatalytic disinfection nano composite paints can be prepared by variety of doping reported in the literature and be used for painting at public places to control the spread of SARS-CoV-2.

Conclusion:

The pandemic of coronavirus disease started in Dec. 2019 in China (COVID-19) is caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection and still spreading with devasting consequences in mortality and morbidity of human life, as well as affecting the global economy. The long lasting of COVID -19 may be due to the existence of SARS-CoV-2 on surfaces in public locations and most likely to blame for the spread. Antimicrobial coatings that are now utilised in hospitals may not be acceptable, viable, or cost-effective to maintain the cleanliness at the

public places and control the spread of SARS-CoV-2. In this situation, an additional approach of photocatalytic disinfection using nanocomposite painting sensitive to visible light is suggested to control the spread of SARS-CoV-2. The principle and mechanism of photocatalytic disinfection is briefed in section 6 of this paper. Further,

the potential technology of formulation of visible light photocatalytic nanocomposite smart paint is described in section 7 above. This innovative technology needs to be supported and

encouraged the paint industries to come forwarded for its large scale applications to control the spread of SARS-CoV-2 and its variants to irradicate COVID-19 situation.

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