Carbon and zinc oxide synthesized by gelatin template as potential material for fight viruses covid-19: Future potential material

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Abstract. The COVID-19 pandemic that attacks the respiratory tract is spreading rapidly to all regions in Indonesia. In this pandemic situation, daily products such as sprays, tissue paper and masks need to be developed using nanomaterials. In this paper, graphite carbon and zinc oxide were synthesized using gelatin as a pore guide. The morphology and character of graphite carbon and zinc oxide were characterized by SEM, EDX and XRD to address appropriate active centers to counteract the protein spike interaction in covid-19 with ACE in the human body. Several illustrations are presented in this paper to understand the opportunity of carbon and zinc oxide materials as the basis for making antiviral devices to store viral molecules so that human-to-human transmission can be prevented. Keyword: graphitic carbon, zinc oxide, COVID-19, antiviruses

1. Introduction
Corona 2 virus which causes severe respiratory infection or often called SARS-CoV-2 (The Severe Acute Respiratory Syndrome Corona Virus 2) causes the emergence of a new type of corona virus in 2019 called coronavirus disease or COVID-19 [1–2]. Transmission of COVID-19 took place very quickly with an indication in the 6 months since its appearance in the world has claimed 619,593 lives with a total number of cases reaching more than 15 million by mid-June 2020 [3]. When the transmembrane called Spike protein from SARS-CoV-2 interacts with a receptor called Angiotensin-Converting Enzyme 2 (ACE2) in the human body, ACE2 gives access to the virus entry to the cell surface of the organ marked by the virus that begins to multiply in the human body. [2]. That's why antiviral material is needed to prevent and combat the spread of COVID-19. Nanomaterials have received a lot of attention as antiviral materials for the prevention and control of COVID-19 because of several advantages of nanomaterial properties such as regular structure and antiviral properties in them [8–9]. One example is the application of immunomodulatory proteins encapsulated by nanoparticles which successfully counteract and eradicate SARS-CoV-2 [3–4].

The nanoscale material which is widely applied in the medical world is carbon and zinc oxide [5]. Graphitic carbon and zinc oxide material is hydrophobic with a two-dimensional structure. Graphitic
carbon is in the form of a sp2-hybridized carbon layer [6]. However, naturally, graphitic carbon and zinc oxide has hydrophilic and electronic properties [7–8]. Even reduction of common carbon and graphitic carbon and zinc oxide by heating will add hydrophilic properties with low oxygen content [9]. Another uniqueness is that the layers on a graphitic carbon stack will interact through the π–π interaction with a special distance due to the presence of an oxygen layer in it [10]. The other material is zinc oxide which has been widely applied in the process of catalysis, drug control delivery, biosensors, biofuels, and uptake [1–3]. Zinc oxide is widely chosen as a catalytic material because it has many advantages, namely thermally stable, chemically inert, inexpensive and harmless [5–7]. The micropore category of zinc oxide is incapable of providing an entryway for applications involving large molecules [8–11].

The most interesting thing about not only carbon graphitic carbon and zinc oxide but also zinc oxide is that it has the ability to move electrons towards bacteria or viruses which is called migration [11–13]. The very negative charge on graphitic carbon and zinc oxide are advantageous because it causes the high affinity of the graphitic carbon and zinc oxide when it moves electrons towards viruses or bacteria which naturally have a very positive charge [14]. This movement or migration of electrons causes cytoplasmic efflux or cytoplasmic depletion in the cell. In addition, electron movement decreases cell metabolism, damages membrane lipids and induces oxidative stress which affects viral damage [4–5]. Besides, the movement of electrons to bacterial or viral cells produces reactive oxygen species that kill viruses and bacteria [6]. Research on the use of graphitic carbon and zinc oxide in feline viruses has shown that graphitic carbon and zinc oxide absorbs viral lipids well through hydrogen bonds and electrostatic interactions [7]. Similar studies have noted that the interaction of graphitic carbon and zinc oxide and virus loads causes the destruction of the viral membrane [8]. This is the basis of this review to predict graphic carbon and zinc oxide that synthesized by gelatin template as a material to fight viruses, especially during this pandemic.

Gelatin is a potential organic molecule as a precursor to carbon. This is based on previous research that the carbon and nitrogen content in gelatin is 50% and 17% [15]. The carbon content in gelatin indicates the ability of gelatin to be converted into carbon. Nitrogen in gelatin is a representation of the amine group as an active group that easily reacts with organic and inorganic substances through physical and chemical bonds [7]. This is evidenced by mixed gelatin with sodium silicate to synthesize graphitic carbon and zinc oxide followed by pyrolysis and silica release. The amine group (–NH2) in gelatin interacts strongly with silicate species which play a role in forming carbon pore walls or zinc oxide through hydrogen bonds. The interaction would stabilize the carbon skeleton even though the synthesis results showed many structural defects when observed by TEM (transmission electron microscopy). The previous research rationale in this study to synthesize graphitic carbon and zinc oxide from gelatin using different techniques in order to obtain carbon products with high regularity [15].

This study examines the synthesis and characterization of carbon graphite and zinc oxide from gelatin as a pore guide using self-assembly techniques. The characters of graphite carbon and zinc oxide were analyzed by SEM, EDX and XRD. Analysis of the potential use of carbon graphite and zinc oxide as a base material to fight Covid-19, achieved an illustrative approach adapted to the characterization results as suggestions for further research.

2. Experimental

2.1 Material

The materials used in this study were gelatin, zinc sulfate, sucrose (Merck, 98%), sulfuric acid, hydrochloric acid, n-hexane, NaOH (Merck, 99%), hydrochloric acid, ethanol, methanol, acetone (Merck, 98%).

2.2 Synthesized graphitic carbon and zinc oxide

Graphite carbon and zinc oxide from gelatin were synthesized according to the procedure of Ulfa et al. (2016) using pore-directing gelatin. The ratio of carbon gelatin and Zn/gelatin on precursor: sulfuric
acid: water was 1.00: 0.2: 100.00 (w/w). The successive synthesis stages are: gelatin infiltration to precursors, dehydration, pyrolysis and washing.

2.3 Characterization
Scanning electron microscopy, EDAX and X-Ray Diffraction were carried out on graphite carbon and zinc oxide. The study in this paper contains predictions that might occur if carbon and zinc oxide are used to restrain the interaction between the spike protein in Covid-19 and ACE-2 in the human body using the electromechanical properties of both materials. After characterization, an analysis will be carried out as outlined in the illustration of the use of carbon graphite and zinc oxide as materials for making equipment to prevent and fight COVID-19.

3. Result and discussion
Figure 1 is the EDAX result of a carbon graphite sample produced from a mixture of gelatin and sucrose which undergoes partial dehydration and carbonization at 100–160 °C for 7 hours. The graphite carbon sample contains 70.5% carbon; 22.5% oxygen; 7.0% nitrogen. The nitrogen content indicates that there is an interaction that facilitates the bonding between the hydrogen in sucrose and the amine groups in the gelatin. According to Hsu et al. (2007) the involvement of hydrogen bonds in sucrose in interactions with gelatin will occur because gelatin has many amino groups that have a high affinity for strong interactions with sucrose. Only a small portion of the gelatin is converted to carbon because the energy used during dehydration and partial carbonization is not sufficient to carbonize all the gelatin molecules. The tentative conclusion, the character of the functional groups of the carbon source and the constituent elements of gelatin shows a strong interaction between gelatin and sucrose in producing graphite carbon.

The zinc oxide in figure 1 (right) contains about 68% zinc and 22% oxygen. The carbon content of about 5% indicates that the gelatin is not completely decomposed at calcination temperature in a precursory mixture of zinc and gelatin as a pore guide. Zinc oxide samples also showed some impurities such as silica and molybdenum in small amounts of precursor impurities. The interaction between the carbon and amine groups in gelatin causes an electrostatic force so that the zinc element attaches to the gelatin micelles to form a morphology like thin glass shards (figure SEM). Electrons in graphite carbon and electrons in the outer orbitals of zinc can undergo migration and attack the virus so that the virus experiences deactivation. The EDX results show that both carbon graphite and zinc oxide are predicted to be capable of fighting viruses through the presence of electrons in the outer orbitals of each element.
Figures 2a dan 2c shows the typical morphology of the synthesized graphitic carbon and zinc oxide from hydrothermal process. Pipe agglomerate shape and smooth surface can be observed in graphitic carbon. The morphology like thin glass broken-structure of zinc oxide shows also in figure 2c. This pipe agglomerate shape-like structure of carbon graphite and thin glass broken-structure-like of zinc oxide is generally a pattern in particle formation because gelatin acts as a molecular guide during infiltration by selecting the surface force with the smallest energy. The XRD patterns of graphite carbon and zinc oxide after high temperature heating are shown in figures 2b and 2d. There are two broad peaks at $= 24.8$ and $43.5$ which are a reflection of plane (002) and plane (101). The vertices can be indexed to a hexagonal graphite grid. The widening of the peaks indicates the presence of an amorphous carbon phase in graphite carbon and zinc oxide [12]. This semi-hexagonal graphite structure takes place during the carbonization process at high temperatures. In the carbonization process, the carbon atoms in the graphite carbon are rearranged to form graphene sheets and partially collapse to produce a pore structure. This structure would be suitable for storage of substances having a molecular size smaller than micropores (<2 nm). Whereas in the XRD pattern of zinc oxide there are typical peaks of wurtzite and a little carbon which confirms the EDX data.

All the results of the characterization, especially the analysis of the elemental content, are a consideration to make an illustrative approach to the use of graphite carbon and zinc oxide as materials for making antiviral sprays, antiviral tissue paper and antiviral masks. The illustration in figures 3–5 is a prediction that can be used to determine whether carbon graphite and zinc oxide have virucidal potential so that in the future it is likely to prove to be an economical and efficient material to fight COVID-19 (figure 3). Figure 1 is an illustration for an antiviral spray. Considerations are made based on the nature of graphite carbon and zinc oxide having distinctive electrons in their molecular orbitals. This outer shell electron will be used as an antiviral center because of its ability to carry out movements that attack proteins in viruses. The affinity, porosity and stability of carbon graphite and zinc oxide have been processed using gelatin as the pore directing agent and functional groups. Gelatin functions to reduce the size of carbon and zinc oxide precursors to a nanometer level so that when used, it is easily dispersed on the surface of the virus. Automatically, the electrons in the outer shell will migrate so that the spike protein in Covid-19 will be damaged so that the virus will die.
Figure 3. Illustration of graphitic carbon and zinc oxide using for spray antiviruses.

Figure 4. Illustration of graphitic carbon and zinc oxide using for paper tissue antiviruses.

Figure 5. Illustration of graphitic carbon and zinc oxide using for paper tissue antiviruses.
Figure 4 is an illustration for creating antivirus tissue which is should be coated with increased hydrophobicity to keep tissue paper dry after washing that will prevent or repel the aerosol transmission of SARS-CoV-2. All these carbon and zinc-based composites would likely be facilitated to combat against the COVID-19 pandemic. The information comprised in this perspective provides a hypothetical approach that would likely help in preventing COVID-19 infection using carbon and zinc products with some development by considering the electro conductive and hydrophobic properties of graphitic carbon and zinc oxide nanomaterials, or their affinity with SARS-CoV-2. Graphitic carbon and zinc oxide nanomaterials conjugated with antivirals can potentially trap and kill SARS-CoV-2. Graphitic carbon and zinc oxide nanomaterials for SARS-CoV-2 can be computationally calculated using docking simulations and molecular dynamics. After that, molecular and cell biology tests can be carried out to determine the trend of interactions between SARS-CoV-2 and ACE2 molecules in living things. Antivirus tissue paper is expected to block the entry of coronavirus when consumers use it in their daily activities.

Figure 5 illustrates the inclusion of carbon and zinc oxide in an antiviral mask. Antiviral masks can be used to clean, protect the surface of the face as well as to maintain sanitation of human body. The presence of migrating electrons in the graphite carbon and zinc oxide in the mask is predicted to be able to block and mask the interaction of the SARS-CoV-2 Spike protein with ACE-2 in the human body. The antiviral mask is expected to be able to disinfect the infected area and prevent the virus from flying to other people. For healthy people, an antiviral mask will protect the face from viruses. Because it can be used repeatedly, this antivirus mask is more economical.

4. Conclusion
Graphite carbon and zinc oxide have a carbon atom and a zinc atom which have electron peculiarities. This second electron movement is predicted to be able to counter the interaction between the community of Covid-19 and ACE in the respiratory tract. These two materials are predicted to be the basic material as spray, paper tissue and masker antiviruses that have been blocked in the interaction between S-protein and human ACE2.

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References
[1] Cui F and Zhou H S 2020 Biosens. Bioelectron. 165 112349
[2] Aydemir D and Ulusu N N 2020 Travel Med. Infect. Dis. 101697
[3] Song Z, Wang X, Zhu G, Nian Q, Zhou H, Yang D, Qin C and Tang R 2015 Small 11 1771
[4] Kong X et al. 2020 Chem. Eng. J 399 125808
[5] Trikkaliotis D G, Mitropoulos A C and Kyzas G Z 2020 600 Chem. Eng. J 124928
[6] Ward S, Lindsay A, Courter J and Assa’ad A 2020 J. Allergy Clin. Immunol. 146 23
[7] Rahman A R, Leili M, Azarian G and Poormohammadi A 2020 Sci. Tot. Env. 740 140207
[8] Sun J, Bi H, Jia H, Su S, Dong H, Xie X and Sun L 2020 Sci. Tot. Env. 244 118814
[9] Sharma N, Tripathi S K and Bhardwaj N K 2020 Ind. Crops Prod. 149 112316
[10] Böger B, Fachi M M, Vilhena R O, Cobre A de F, Tonin F S and Pontarolo R 2020 American. J. Infect. Control 7 11
[11] Sui L, Wang Y, Ji W, Kang H, Dong L and Yu L 2017 Ind. Crops Prod. 42 29820
[12] Szczęśniak B, Phuriragpitikhon J, Choma J and Jaroniec M 2020 J. Colloid Interface. Sci 577 163
[13] Raghav P K and Mohanty S 2020 Med. Hypotheses 144 110031
[14] Mujawar M A, Gohel H, Bhardwaj S K, Srinivasan S and Hickman N 2020 Mat. Today Chem. 17 100306
[15] Ravinayagam V and Rehman S 2020 Saudi J. Bio. Sci. 27 1726
[16] Han H, Luo Q, Mo F, Long L and Zheng W 2020 Lancet Infect. Dis. 20 655
[17] Ulfa M, Prasetyoko D, Mahadi A H and Bahruji H 2019 Sci. Tot. Env 711 135066