Can *Plastic Waste Management* Be a Novel Solution in Combating the Novel Coronavirus (COVID-19)? A Short Research Note

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Abstract

The year 2020, has been noted to be of major calamity the world over, where majority of efforts in research and development are dedicated towards combating the threat of the novel Coronavirus (COVID-19). Ever since the announcement of COVID-19 as a pandemic, such efforts where dedicated towards the research of its spread and vaccination. Yet still, the world might reach to a resolution via an environmental solution that various entities have overlooked with a plethora of environmental benefits *visa ve* waste management. In this short communication, the possibility of using plastic solid waste (PSW) as a substrate to employ copper, and copper alloys and their nanocomposite nanopowders to be used as permanent surface protective coats, is presented. The fact that we present such materials to be of waste origin is an added value advantage to their beneficial advantage of developing various commodities and products that could be used in our daily lives. Furthermore, the fact that such recylate materials are susceptible to anti-viral properties and chemicals, is an added value that we should not neglect.

Keywords: COVID-19, Plastic Waste, Solid Waste, Antiviral, Nanopowder.

1. Background

Towards the end of 2019, a novel *Coronavirus* which was later termed as COVID-19, has started to spread the world over with a clear exponential growth rate throughout population clusters within the Far-East moving towards the globe. COVID-19 has started in Wuhan (China) and was later identified as a type of pneumonia causing virus that started to claim lives due to its severity and acute symptoms [1]. As of 11th March 2020 (the time of initial draft write-up of this communication), COVID-19 has claimed the lives of 4,292 globally with 118,322 confirmed cases including 80,955 cases in China alone [2]. On the very same date, the World Health Organization (WHO) has declared COVID-19 to be a global pandemic [3]. The virus has claimed over 584,556 lives with a confirmed number of cases surpassing 15.5 million till mid-July 2020. The outbreak is still considered to be ongoing and has caused more financial and global health concerns in comparison to the other two Coronaviruses, the severe acute respiratory syndrome coronavirus, SARS-CoV; and the Middle East respiratory syndrome coronavirus, MERS) [4]. These concerns were escalated further when various governments (including China's) adopted extreme measures in banning public traffic within city-centres, social gatherings, festivals and inbound/outbound transport services [5]. The aforementioned events have contributed greatly to the global panic faced by many developed and developing countries alike, especially when considering the fact that COVID-19 was characterised with a short serial interval (e.g. five days) of symptoms with high mortality rate unlike the other two Coronaviruses [6]. We therefore aim to present in this communication a short research note that presents a novel idea where a material is compounded and coated from plastic solid waste (PSW) and coated with nanopowders that could also be originating from solid waste (SW) sources; and used an antiviral surface against COVID-19. We also discuss the available literature on the concept, considering how scant it is, with an aim of presenting an idea that could be affectively used in the healthcare facilities sector amongst other applications (e.g. transportation, commercial goods, etc). By that, transportation of viruses via touch and contact with commercial goods is minimised to a great extent, which is the main route of viral transfer among the residential clusters.

2. Current Research Trends

Understandably, an increasing interest has been noted as of late in COVID-19 research works. Various research institutes and academic bodies, notably within the People's Republic of China, have started boosting their research efforts in the field of developing vaccines and taking those trials to field by introducing the human element. Outside China, the US alone has signed off an 8.3 Billion $ research fund to take human trials to the next level courtesy of the Centre for Disease Control (CDC) [7]. A simple literally search using the keyword 'Coronavirus' on the database Sciencedirect® turns 14,010 results with a vast number of research articles (6,211) as of 11th March 2020. The total number of results slims down to 699 search hits for the year 2020. Using the same keyword on Google Scholar® and SCOPUS® results in a 163,000 and 18,543 search results, respectively, which also narrows down to 3,430 and 429 for the year 2020 with respect to each database. Narrowing down the search to a more related search strategy using the keyword 'COVID-19' shows a total search result in Sciencedirect®, Google Scholar® and SCOPUS®, of 257, 1,310 and 62 research related works as of the year 2020, respectively. Other than vaccine related works and medication pertaining the case at hand, there seems to be an understandable serge in research work related to the basic understanding of both virus strains (e.g. *L* and *S* Coronavirus strains), characterisation and infection routes of COVID-19 [1,8-10] and understanding the spread and distribution (including forecasting) of this virus [11-12]. The aforementioned cites some of the literally work but certainly not a bulk of it, since it falls out of the scope of this communication.

3. Substrates Comprised of Waste Plastics for Antiviral Surfaces

The world has been combating the problem of SW accumulation, and namely PSW, for the past few decades. Plastics have replaced almost all materials used in every known application, including the medical field, due to various reasons namely its flexibility, versatility and high hygienic properties used in food industries and certainly medical applications [13]. The increasing use of such products will inevitability increase PSW due to mismanaged waste components and lack of infrastructures in various regions of the world. To date, the total PSW produced on a global scale in accordance with World Bank statistics is estimated at 242 million tonnes per annum [14]. The hierarchy to treat and mange PSW streams is also well known and has been researched extensively in the past, including impact of recycling and heating loops, and degradation/environmental exposure of plastics with relation to impact on its integrity [15-17]. It is our belief in this communication that we have to start introducing an important concept that has the potential to be viable on two fronts, the environmental management of waste components namely PSW; and the medical application field of having an antiviral surface that originates from waste.

The use of plastics, namely those that are susceptible to heat and recycling treatment (thermoplastics), as surfaces for antiviral agents is not something that is exactly new. The use of thermoplastics as substrates for antiviral (and even antimicrobial) surfaces follows suit to past works on development of antimicrobial binding agents for paper [18], antimicrobial and antiviral cottons [19] and fabrics [20]. Yao [21] has developed (subsequently patented) a substrate of thermoplastic which could be polyethylene based amongst other types of polymers, that is suitable as an antiviral surface. Preferred antiviral or antimicrobial agents incorporated where 2,4,4'- trichloro-2'-hydroxy-diphenyl ether, 3-(4-chlorophenyl)-1- (3,4-dichlorophenyl) urea, silver ions, and salts and mixtures thereof. In an earlier attempt, Snyder Jr. and Brockport [22] have developed a method for imparting anti-pathogenic properties on substrates as the coat was effective to be versatile and used in various fields. The recent COVID-19 outbreak has also revived work on *Chloroquine* as a new antiviral agent originating from quinine compound which is naturally abundant in the Cinchona trees [23-24]. Past experiences with Chloroquine showed various success stories as a drug of choice against other types of Coronavirus, influenza types A and B, and HIV [25-28]. With the exception of cellulose based filters. Chloroquine has proven high in sorption rate and sorption kinetics which shows great potential for developing it further as a drug of choice for antiviral plastic surfaces [29].

The concept of developing a hygienic surface susceptible for antiviral agents on recycled plastic, paves the way to a highly economical rate of return with versatile and wide applications. This application could find its way also in electrical appliances (plastic coats on screens and keypads), hand sanitizer depots, plastic door handles, pens, bank cards, coffee shops surface areas for customers and others. Needless to say, the medical application field will be of better potential not only for economic benefits but also safety purposes compared to plastics used through conventional mechanical recycling. The environmental implications of this idea could be of grand potential in the current climate of research and development with great emphasis of new research trends we are called to address due to the global spread of COVID-19. At present, the general consensus and method for combating COVID-19 seems to be based on the rather simplistic approach of surface swaps and clean-ups. Surfaces are recommended to be swiped with organic agents that are well known to kill the deposited viruses. In fact, using such organic based antiviral agents, taking chloroquine as a typical examples have severe disadvantages and limitations. These could be summarised as a short lived requiring constant re-swiping and re-applying to the surfaces, and possess noxious ingredients with harmful environmental implications to produce or process. Therefore, it is necessary to employ different types of such agents that are environmentally friendly and working untruly with the substrates without causing degradations. They must possess a high degree of biocompatibility and great effect as viral protective coating. They can be used efficiently for frequently touched surfaces made from different materials, in particularly plastic waste.

Therefore, employing plastic waste surfaces can also present the advantage of having copper, and copper alloys and their nanocomposite *nanopowders* to be used as permanent surface protective coating the recycled plastic surfaces against COVID-19. The use of such nan-coats can easily be applied on such surfaces which also presents a new venture for this idea of using PSW as a means to develop antiviral surfaces. Copper and its alloys and nanocomposites can be safely used to coat all types of solid materials without exceptions. The US Environmental Protection Agency (EPA) registers 355 copper alloys with public health claim [30]. The products made from any of these registered alloys are legally permitted to make public health claims relating to the control of organisms that pose a threat to human health. In order to ensure successful coating process and to produce homogeneous porosity-free plastic coated systems by copper or copper alloys, cold spray coating technology is proposed [31]. In contrast to the conventional thermal spray approach, cold spray is a solid-state process, in which the copper nanopowders feedstock remain in their solid form without melting and/or grain growth. The production of such surfaces could pave the way for a having an antiviral product that would ideally encompass over 90% by weight of PSW in it [32]. Such a high content of PSW would be sufficient from plastic film waste [33]. This also presents new opportunities for having substrates from biodegradable (hydro-based) plastic blends that could be used as a *greener* alternative as well. It should also be stated that there is a clear economic impact for proposing such a product at these difficult time where COVID-19 has resulted in various job losses and economic burdens [34-35]. The master-alloy (e.g. Ag, Cu, based) could be valorised from industrial waste sources. The production of such a SW based product will cost minimal production amounts, and will result in (i) diversifying the research trends of the future, merging engineering and bio-technology sciences, (ii) create economic opportunities that could be in new job opportunities for antiviral and protection equipment for medical sectors, and finally; (iii) decrease infection and transfer of COVID-19 in vital sectors such as the healthcare system.

Furthermore, the research concept presented here can also present a paramount solution for the healthcare sector the world over. Preventing the COVID-19 from transferring through various routes within medical facilities is vital to minimise risk of patients. There still exists various medical equipment and applications that could be replaced with such a concept namely in surgical theatres or the medical supply chain in general [36-37]. Such a concept could also be used for flooring and roofing in healthcare facilities to reduce contamination or transportation of the virus amongst vulnerable patients. Furthermore, it could also be implemented for masks and face shields as part of personal protection equipment (PPE) that require a dedicated separation, sorting and recycling line dedicated within an integrated SW management scheme due to the nature of its materials. The production of such a material in a form of a product could also be integrated within a holistic SW management system. Either Material Recovery Facilities (MRF) or mechanical sorting lines could segregate the polyolefin based waste for further processing and compounding. This will not have an additional toll on the design of existing infrastructure as it stands. It will also reduce environmental indicators due to the green and environmentally friendly nature of the product that utilises a SW feedstock.

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