

Can Advanced Materials Save Public Health...Again?

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Public Health is in crisis.

An outbreak of a novel strain of coronavirus was first reported in Wuhan, China, in December 2019. This outbreak set in motion a chain of events that has had severe repercussions across the world. On March 11, 2020, the World Health Organization (WHO) declared the disease (Covid-19) caused by this new virus (SARS-CoV-2) a global pandemic. The outbreak of SARS-CoV-2 brought to light current and long-term failures of public health, culminating in a recurring disaster of epic proportions. These failures have not just been confined to the health front, but they have also affected social and political structures, as most disasters tend to do.

The current crisis set off by Covid-19 was caused by a history of poor decision-making, and the crisis continues to reveal the consequences of these actions. The recurring ripples of public health policy that have had the greatest impact on the current crisis are (1) years of defunding public health programs and initiatives, and (2) a reluctance of the Public Health Community to adopt new technologies. These decisions have contributed to outdated technology, institutions, and governance in Public Health as well as a lack of planning and preparedness for many public health crises, most notably a pandemic.

Partnerships is a fundamental concept in Public Health, yet the community failed to unify in this moment of crisis. More importantly, while facing a threat that was rapidly spiraling out of control, the Public Health community failed to fully embrace all available resources, especially non-traditional partners with an arsenal of tools and resources at their disposal that could offer solutions to gaps that are not currently being filled by traditional Public Health institutions.

At the same time that the coronavirus was illuminating the fractures of the global Public Health System, the Advanced Materials Community, which has been sitting patiently on the sidelines waiting for its moment to shine, was quietly mobilizing. Research institutions, commercial entities, and individuals with expert knowledge of advanced materials were starting to call one another and identify current health challenges that could possibly be addressed by their technologies and years of research experience.

Pockets of innovation have been present throughout this crisis, but the Public Health Community has not had the opportunity to benefit from the full impact of advanced materials solutions due to the lack of a unified and coordinated response. Advanced materials have been a part of public health for nearly a century and have contributed greatly to improvements in quality of care, patient outcomes, and prevention. However, the integral role that advanced materials has played and can continue to play in promoting public health has largely been forgotten or been overlooked in this current crisis.

Ceramics were among the first advanced materials to be adopted by the medical profession when they were used for orthopedics and dentistry in the 1930s. However, the large-scale introduction of plastics into the healthcare system in the 1960's tipped the scale in terms of providing durable, cost-effective, and easily mass-produced products for widespread public health use. The use of plastics has become so ingrained in healthcare that the title of a 2019 National Geographic article asks the question, "Can medical care exist without plastic?"

Carbon fiber (CF) and carbon fiber reinforced plastic (CFRP) were successfully introduced into prosthetic and orthotic design in the late 1960s and early 1970s. By the mid 1980s, CF and CFRP were routinely used in the manufacture of prosthetics given its extreme light weight, strength, and ability to conform more easily to contours of the human body.

Gloves, masks, and other forms of personal protective equipment (PPE) are a cornerstone of modern public health, and as such, often benefit the most from advances in material design. One of the most important applications of advanced materials in PPE was the development of the non-woven textiles used for N95 respirators, first introduced in 1972 then upgraded to more adequately filter viral particles in 1995. The introduction of nitrile gloves in the mid 1990s provided a key solution to latex sensitivity and allergy

experienced by many public health professionals following the widespread use of latex gloves. In the words of textile researchers Dolez and Vu-Khanh, “Decisive progress has been achieved in terms of improvement of PPE, in particular thanks to intensive research in materials science.”

The introduction of additional material technologies into public health, including engineered nanomaterials, biocompatible polymers, and additive manufacturing, continue to push the envelope in terms of design, reliability, sustainability, and cost. Advanced materials show much promise in improving antimicrobial and anti-fogging coatings; diagnostic tools and equipment; laboratory equipment; testing supplies; PPE; filtration; sensors; and other applications. This current pandemic could possibly be the catalyst for an advanced materials-public health renaissance. Glimmers of this rebirth have already been seen with 3-D printed ventilator parts and face shields and face masks using graphene filtration systems, but widespread and universal adoption still seems far off.

The unfolding crisis appeared to manifest out of nowhere, but in reality, this disaster was decades in the making. These issues have not been lost within the Public Health Community even though they have not been adequately addressed. In January 2020, WHO released its urgent health challenges for the next decade, and five of those challenges are extremely relevant to the current situation:

- Delivering health in conflict and crisis
- Stopping infectious diseases
- Preparing for epidemics
- Investing in the people who defend our health
- Harnessing new technologies

Existing and past policies have led to this point and continuing to follow the same path will not lead to an improvement of the immediate situation nor will it provide a foundation for improving the public health of the future. Adopting new ways to address public health challenges is the only way to prevent another disaster of this scale from occurring.

The Advanced Materials Community has no centralized place to effectively mobilize and support the public health community, and Public Health has few advocates who can see the benefit of using advanced materials to not only address the current crisis but the inevitable fallout and even future crises. It is paramount that the two communities become reunited amidst champions who can understand their own field’s capabilities and weaknesses and are willing to do the same for the other side. It is only through these types of relationships, utilizing all available resources, that the world can hope to prevent or at least reduce the impact of the disaster it is still experiencing and will continue to experience for months and possibly years to come.