# Climate change and materials virology

By **Ahmad R. Kirmani**

Changes in the climate during the past century are likely due to human activities. And it has not taken long for these changes to show dangerous repercussions across the planet. Writers for newspapers, science journals, and magazines and experts in the field have voiced warnings about the catastrophic effects on the Earth because of our overreliance on nonrenewable energy. Increasing concentrations of greenhouse gases in the atmosphere, rising ocean temperatures, alarming sea levels worldwide, melting polar caps, and the shrinking Antarctica are only some of the signs that should convince even the harshest of skeptics that climate change is real and has arrived.[1,2] More troubling is the strengthening evidence that it may not be possible to undo the negative effects of climate change caused by humans: We may have reached the tipping point. Some recent reports suggest that existing climate change models might have been underestimating the extent of environmental damage caused to the planet.[3,4]

One alarming example is the fast-melting Siberian permafrost. A consequence is that as the ice melts, dangerous, giant viruses, snoozing underneath thick sheets of polar ice for millions of years, are crawling back to life.[5] Some of these might have caused global epidemics in the past, although they have not interacted with life forms on Earth since they were frozen in the tundra. Troublesome, indeed, is the realization that we do not yet have any antibiotics available to thwart these microbes. The history of these viruses is still being researched and is not completely understood. Some of these viruses have been discovered recently in Siberian surveys, and these specimens are very different (in terms of genome size, etc.) from the viruses we commonly deal with and have the vaccines to thwart the effects of today. It might be a matter of time until never-before-heard-of diseases begin to sweep across the globe, as these malicious viruses thaw.

Materials science stands to play an important role in stalling the current climatic plunge as it liaises strongly with the science and understanding of our environment. Materials and biological sciences have worked in tandem, leading to various scientific breakthroughs. Soft matter, such as biomaterials, are becoming more important in materials science, with a recent milestone being the advent of DNA nanotechnology. In the context of viruses, initial forays into the structural understanding of viruses and life forms at the submicron scale were made possible by employing the materials characterization tool chest, such as x-ray diffractometers and electron microscopes.[6] Cryo-electron microscopy was specifically developed for the structural determination of biomolecules, such as HIV,[7] leading to a Nobel Prize in Chemistry in 2017.

An interesting direction for the near future in this arena is materials virology. Studying the structure–property relationships of viral assemblies in ultracold conditions by employing materials characterization tools has the potential of shedding light on interactions of viruses with live matter. X-ray scattering of virus crystals under conditions similar to those in the tundra might lead to clues about how potentially deadly pathogens in melting polar caps are coming to life, and if it might be possible to put them back into hibernation. Crucial insights into possible phase transitions of these pathogenic assemblies might be brought to light.

As the permafrost heats up and viruses—some being giant, micron-sized with enormous genomes—come back to life,[8] there is much that needs to be understood about them. Materials virology could be an exciting career path for young researchers at the intersection of materials science and biology who are interested in saving the planet from some of the ill effects of climate change, in addition to exploring the interesting structures of viruses and viral assemblies. The rich information that materials virologists could glean about the behavioral dynamics of tundra pathogens could, in the future, help control uncommon diseases and epidemics that might otherwise become a reality.

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