Global Challenges Foundation

Nanotechnology

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Risks and opportunities from mature nanotechnology

While the products of present-day nanotechnology research pose risks for society, these do not currently constitute global catastrophic risks. However, nanotechnology research may eventually allow us to arrange matter with atomic resolution, with tremendous specificity and flexibility, and at very low cost. This technology, which for the purposes of this article I'll call "mature nanotechnology", could be a general purpose technology comparable to the steam engine or electricity, with profound and wide-ranging implications. We should be hopeful that this technology would lead to great material wealth for the whole of society, but we must also consider the dangers that the technology could imply.

Opportunities

Mature nanotechnology could imply new, highly effective medical interventions, for example through the use of nano- or micro-scale autonomous drones delivering targeted interventions within the body.

Technological solutions from mature nanotechnology might also allow us to reduce or eliminate some sources of global catastrophic risk. Cheap and atomically precise fabrication might enable the manufacture of extremely high performance solar panels and carbon capture and storage devices, allowing us to tackle and perhaps ultimately solve climate change. It could also provide us with powerful tools for reducing biorisk, such as ubiquitous biosurveillance for early detection of dangerous pathogens. On a grander scale, perhaps the availability of cheap, high performance materials and abundant energy would eventually allow us to settle the stars, which could increase our resilience against civilisation-scale risks.

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Risks

Such a powerful technology could, however, also enable new sources of global catastrophic risk.

Mature nanotechnology could enable ultra-powerful surveillance, for example by enabling the ubiquitous presence of tiny autonomous drones continuously reporting on individuals' activities. In an extreme scenario, this capability could lock in an existing global totalitarian regime, constituting a severe global catastrophe.

The technology could also allow states to develop high-precision and possibly non-lethal weapons, further boosting state control. Perhaps even more worryingly, mature nanotechnology might make it easy for individual actors to manufacture highly destructive weapons; to get some feel for this scenario, picture a world where nuclear weapons or dangerous pathogens can be manufactured with everyday household materials.

Mature nanotechnology might also provide routes for accelerated development of artificial intelligence (and perhaps Artificial General Intelligence) and its associated risks by enabling cheap and highly advanced neurotechnology and computers, providing insights for artificial intelligence research and better hardware for existing computer algorithms.

"Mature nanotechnology could enable ultra-powerful surveillance..."

Policy

The transformative implications described above are very speculative; and it appears likely that they are at least decades away, if they ever materialise. However, it seems prudent to be prepared for unexpectedly rapid progress in nanotechnology R&D, just as we should be prepared for other low probability, very high impact events. To this end, international arms control institutions should ensure they have access to sufficient scientific expertise to keep them apprised of risks from emerging technologies, including those from advanced nanotechnology.