stable than luminescent organic materials.
For semiconducting polymers, insulation has the potential to eliminate cofacial π-interactions and thereby dramatically increase their stability.
The polyrotaxane approach results in isolation of the polymer chains and should thereby enhance the stability of these materials. Indeed, one of the authors of the present work has previously shown this effect in the stabilization of small molecules in rotaxane complexes[3].

Total encapsulation of molecular wires by insulation has the potential to enable the stabilization of a greater variety of electronic structures. One spectacular demonstration of this potential was the isolation of cyclobutadiene in molecular cavities[4]. Cyclobutadiene is too short-lived in solution to be studied. However, when placed in a cavity and insulated from its surroundings, cyclobutadiene is stable and can be isolated. The metallic organic molecular wires of the future are expected to have similarly high reactivities. This feature is due to the fact that their electronic structure will have occupied and unoccupied orbitals separated by infinitesimal differences in energy, which allow for mobile electrons but also increase the reactivity. The use of molecular insulation should permit these materials to attain the durability required for use in emerging molecular electronic technologies.

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MATERIAL WITNESS

Nanotech nightmare

Grey goo is sticky stuff. This nanotechnological nightmare raised its head recently at a performance of *Three Tales* by the US composer Steve Reich and the visual artist Beryl Korot. An exploration of the influences of modern technology, this striking work was followed by a post-performance discussion in which Korot spoke of Bill Joy's now notorious article in Wired magazine two years ago, cautioning of the potential dangers of self-replicating nano-robots.

The idea stems from Eric Drexler's 1986 book *Engines of Creation*, in which he suggested that such 'nanobots', designed to build new replicas of themselves atom by atom, might run amok and remake everything in their image, reducing the world to a grey sludge of intricate but pointless little machines. To Joy, such prospects might warrant our refraining from some areas of research.

Since then, this doomsday prophecy has grown legs. Last August the *New York Times* reported how environmental groups such as the ETC Group in Winnipeg, Canada, are arguing for a 'go-slow' approach on nanotechnology. ETC is calling for 'a moratorium on molecular self-assembly and self-replication'. And it is not just those on the outside looking in who are sounding the alarm bells. Martin Rees, the UK Astronomer Royal, recently mentioned 'replicating nano-machines' as a potential cause of mankind's extinction.

Unforeseen consequences of technology are as old as history, but perhaps our fears became heightened in the later twentieth century when the dangers — radiation, carcinogens, CFCs — turned invisible. The threat of what we can't see is always the worst.

On the other hand, the power of the Grey Goo image surely stems from its visual appeal. It is tailor-made for Hollywood: trees, buildings, people dissolve before the advance of a sticky tide of nano-mud. This is why the idea is here to stay. One can hardly blame Drexler for painting this almost irresistibly dreadful picture, but it is hard to know how seriously he wanted us to take it. From today's perspective, it is quite as absurd as *Star Trek*'s teleporters; but like them it is utterly catchy. All the best inventions of science fiction have this quality, a kind of dream-like logic that makes us want to believe in them.

Yet I can't help but be struck by the distance between Joy's apocalyptic message and the humble materials chemists proudly assembling their quantum dots. What would they make of an edict that imposes a moratorium on their work for the safety of humankind?

It is one of our most enduring myths that anyone with bad intentions will choose to express them in the most technologically complex way. You want life-threatening replicators? Then set loose a few smallpox viruses. These are nanobots that really work.

At the same time, the Grey Goo debate provides a timely reminder of what a fine line new research disciplines balance on. When nanotechnology is advertised for explicitly military purposes accompanied by a Robocop image of a nano-enhanced soldier, one has to wonder whether it only gets the scaremongers it deserves.

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