

# What is Nano-Technology?

Nanotechnology is a field of research and innovation concerned with building 'things' — generally, materials and devices — on the scale of atoms and molecules. A nanometre is one-billionth of a metre: ten times the diameter of a hydrogen atom. The diameter of a human hair is, on average, 80,000 nanometres.

At such scales, the ordinary rules of physics and chemistry no longer apply. For instance, materials' characteristics, such as their colour, strength, conductivity and reactivity, can differ substantially between the nanoscale and the macro. Carbon 'nanotubules' are 100 times stronger than steel but six times lighter.

Nanotechnology is hailed as having the potential to increase the efficiency of energy consumption, help clean the environment, and solve major health problems. It is said to be able to massively increase manufacturing production at significantly reduced costs. Products of nanotechnology will be smaller, cheaper, lighter yet more functional and require less energy and fewer raw materials to manufacture, claim nanotech advocates.

Activists worry that the science and development of nanotechnology will progress faster than policy-makers can devise appropriate regulatory measures. They say an informed debate must take place to determine the balance between risks and benefits.

## Global market expands

The US National Science Foundation predicts that the global market for nanotech-based products will exceed US\$1 trillion within 15 years. Paul Miller, senior researcher at the British policy research organisation Demos, said in 2002 that 'already, roughly one-third of the research budgets of the biggest science-based firms in the US is going into nanotech' while the US National Nanotechnology Initiative's budget rose from US\$116 million in 1997 to a requested US\$849 million in 2004.

In the developing world, Brazil, Chile, China, India, the Philippines, South Korea, South Africa and Thailand have shown their commitment to nanotechnology by establishing government-funded programmes and research institutes.

In May 2004, the Thai government announced plans to use nanotechnology in one per cent of all consumer products by 2013. Their market value by then is predicted to be 13 trillion baht (more than US\$320 billion at contemporary exchange rates). Indeed, Thailand has wholeheartedly embraced nanotechnology and its development is a major commitment of the Thai government. Likewise, China announced in May 2004 that nanotechnology is central to its long-term national science and technology plan.

What are the potential benefits for developing countries?

Nanotechnology holds the promise of new solutions to problems that hinder the development of poor countries, especially in relation to health and sanitation, food security, and the environment.

In its 2005 report entitled *Innovation: applying knowledge in development*, the UN Millennium Project task force on science technology and innovation wrote that 'nanotechnology is likely to be particularly important in the developing world, because it involves little labour, land or maintenance; it is highly productive and inexpensive; and it requires only modest amounts of materials and energy.'

Nanotechnology is already useful as a tool in health care research. In January 2005, researchers at the US Massachusetts Institute of Technology used 'optical tweezers' — pairs of tiny glass beads are brought together or moved apart using laser beams — to study the elasticity of red blood cells that are infected with the malaria parasite. The technique is helping researchers to better understand how malaria spreads through the body.

But nanotechnology could also one day lead to cheaper, more reliable systems for drug-delivery. For example, materials that are built on the nanoscale can provide encapsulation systems that protect and secrete the enclosed drugs in a slow and controlled manner. This could be a valuable solution in countries that don't have adequate storage facilities and distribution networks, and for patients on complex drug regimens who cannot afford the time or money to travel long distances for a medical visit.

Water purification systems could benefit from filters that are structured on the nanoscale offering the promise of better and cheaper systems that are long-lasting and can be cleaned. Other similar technologies could absorb or neutralise toxic materials, such as arsenic, that poison the water table in many countries including India and Bangladesh.

## What are the concerns?

A major concern is lack of research into nanotechnology's potential threats to human health, society and the environment. In a paper published early in 2003, Anisa Mnyusiwalla, Abdallah Daar and Peter Singer, of the University of Toronto, Canada, wrote, 'As the science of nanotechnology leaps ahead, the ethics lags behind. ... We believe that there is danger of derailing nanotechnology if serious study of its ethical, environmental, economic, legal and social implications does not reach the speed of progress in the science.'

According to Singer and his colleagues, in 2001, the US-based National Nanotechnology Initiative allocated US\$16-28 million to studying societal implications, but spent less than half that amount.

Several non-governmental organisations are calling for greater risk evaluations or, in the case of Canada's ETC Group, a nanotech research moratorium. They, and others including the US-based Centre for Responsible Nanotechnology, have raised concerns about the following aspects of nanotechnology:

- The toxicity of bulk material, such as solid silver, does not help predict the toxicity of nanoparticles of that same material. Nanoparticles have the potential to remain and accumulate in the environment. They could accumulate in the food chain. They could have unforeseen impacts on human health. The public has not been sufficiently involved in debates on the applications, uses, and regulation of nanotechnology. 'Grey goo': Tiny robots generated with nanotechnology could self-replicate. In the rich countries are the main drivers of the development of nanotechnology, applications which benefit developing nations will be side-lined. Unless rapid action is taken, research into nanotechnology could progress faster than systems can be put in place to regulate its applications and their uses.

Although some of these concerns, mainly the 'grey goo' theory, have been widely discredited by researchers in the field, most remain high on the agenda of activists. The ETC Group has demanded that a UN moratorium be placed on all nanotechnology applications that could come into contact with the human body.

The ETC Group has also expressed concern that the control of nanotechnology research and development might remain firmly in the hands of industrialised nations. The result would be a bias towards developing applications that benefit rich countries but neglect the needs of the poor.

But what of the 'unknowns'? Is nanotechnology over-hyped? Can it fulfil its promise without comprising social norms and security? Are its proponents realistic in their claims of what nanotechnology can achieve? Or is it a runaway technology destined to wreak havoc with human health and the natural environment?

Assessing the role of nanotechnology and guiding its progression will require cross-sectoral involvement of scientists, governments, civil society organisations and the general public. Informed debate is essential to try to avoid the polarisation of views illustrated by the issue of genetic modification.

## Acknowledgement

The above information comes from the Science and Development Network whose aim is to enhance the provision of reliable and authoritative information on science- and technology-related issues that impact on the economic and social development of developing countries. It seeks to achieve this objective primarily through running a free-access website, but also by building regional networks of individuals and institutions who share its goals and by organising capacity-building workshops and other events in the developing world. See [www.scidev.net](http://www.scidev.net)