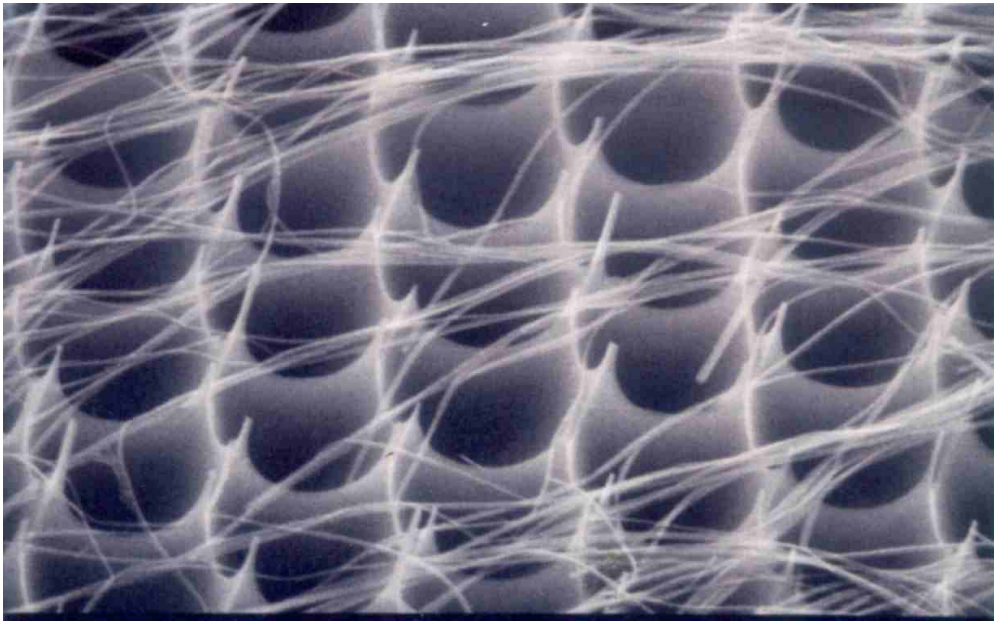


Nanotechnology

Opportunities & Risks



Source: Philips

Nanotechnology – an ethical investment?



Nanotechnology has the capacity to change many aspects of our lives and like any new technology offers both tremendous opportunities for social and environmental advancement, but also carries many

dangers. Given the potential impact that nanotechnology could make, it is surprising that the public have seemed relatively disinterested, and as a result, companies have not felt compelled to be as transparent as they might otherwise be in communicating their policy with regard to nanotechnology. So what are the challenges posed by nanotechnology for ethical investors, and what are the opportunities?

Nanotechnology - what does it mean to you? For many of us, the answer seems to be 'not a lot'. In a survey commissioned by The Royal Society, only 29% of those surveyed had even heard of it and only 19% actually knew what it is, yet the potential impact of this technology is such that some regard it as a new industrial age. Not that Nanotechnology is really that new – scientists have been working at this scale for years – but the widespread applications are potentially revolutionary and have the capacity to change healthcare, agriculture, communications, energy, water, transport, clothing, computing, construction and much more besides, so its really rather important that we do understand it, especially given undoubted dangers posed by this emerging technology.

Nanotechnology is the application of technology at the nano scale, which in layman's terms means very, very small. A nanometre is one thousand millionth of a metre, being equal to

1/80,000th of the width of a single hair, and the ability to operate on this scale is akin to being able to clip Lego blocks together for the first time instead of just piling them in a heap. Apart from the vastly increased precision, operating at the nano scale has two key characteristics:

- Materials have a relatively large surface area and are therefore more chemically reactive
- The behaviour of materials may alter, with different optical, electrical and magnetic properties

The latter characteristic is especially profound, since it means that materials can be produced that can take on different functions. For example, sunscreens can be designed to block UV light but remain clear; windows can be coated to become self-cleaning and particles can be introduced to make a rigid material, flexible. The list of potential applications is almost endless from increased miniaturisation in electronics to super-strong lightweight materials; to sensors for chemicals, food safety and stresses in buildings; to disease diagnosis, drug delivery, molecular imaging and anti-microbial dressings; and to reduced use of resources in industrial processes that might lead to a tenfold reduction in the cost of solar power, a 10 – 100 fold decrease in the cost of fuel cells and a 10 – 100 fold increase in the efficiency of batteries.



Given the capacity of Nanotechnology to change so impinge upon so many aspects of our lives, it is not surprising that there is a great deal of excitement it's investment potential. At the same time, there is a wariness borne of the tech bubble which may lead some investors to stand on the sidelines, but this denies the very real opportunities that nanotech offers. Not that the evidence to date is very compelling: over the last three years, the indices that track nanotech stocks in the United States have fallen in value whilst the US market as a whole has risen. Like all technologies, the small, specialist companies are often gobbled up by larger, better resourced multinationals that are better able to exploit the technology. Furthermore, Nanotechnology has such widespread application, that it will probably become part of a great many companies operations just as information technology enhances the operation of businesses today. Nevertheless for some businesses, nanotech will enable them to establish leadership in their field by reducing costs and energy consumption, or by adding functionality or efficacy.

A number of stocks that commonly appear in ethical portfolios utilise Nanotechnology, albeit much of the activity is still in the research stage. It would be wrong to underplay the significance of Nanotechnology, however, with sales of products using nanotech predicted to rise from 0.1% of global manufacturing output in 2004 to 15% in 2014 (Source: Investor Week 23 February 2007) which equates to the combined size of the information technology and telecommunications industries. In fact, we are experiencing a convergence between these different technologies – bio, information, telecommunications and nano – to deliver solutions that might previously have been undreamt of (see inset).

Nanotechnology Applications

Current

- Sunscreens transparent to visible light but blocking UV
- Packaging - Anti-static and anti-microbial
- Car tyre reinforcement
- Sports equipment – longer lasting tennis balls, stronger tennis racquets, better ski waxes
- Self-cleaning windows
- Clothing - breathable, waterproof, non-staining and creasing

Short-term

- Paints – lightweight and anti-fouling
- Fuel cells – high efficiency and small
- Displays – sharper and more energy efficient
- Batteries – holding more energy
- Solar – thin film application
- Catalysts – more efficient
- Pollution control
- Agriculture – precise application of inputs

Longer-term

- Medical imaging – at the single cell level
- Drug delivery – at the cellular level
- Construction – stress analysis
- Medical implants – longer lasting
- Water treatment – desalination

In the medical field, enhanced drug delivery and discovery allows diseased cells to be targeted on an individual basis, whilst implants can be designed with greater longevity and biocompatibility (see Phillips box). [Johnson Matthey](#) and Polyfuel are improving catalysts used in fuel cells; Applied Materials and ST Microelectronics are using nanotech to dramatically reduce the cost of solar energy and Nokia is at the forefront of multi-use devices that combine telephony with sensing equipment and computing (see profiles below). However, it is the food industry that is at the forefront of the commercialisation of Nanotechnology, with 200 transnationals having invested in the technology. At this stage, most developments have been in the areas of packaging, where nanotech has been used to indicate whether food is safe to eat (changes colour when food spoils) and to keep food and beverages fresher. The benefits of some of these developments are somewhat questionable, however. For example, Kraft is working on interactive foods where its possible to change the colour and flavour of natural ingredients, whilst Unilever and Nestle have focused on improving the texture of foods such as ice-cream. Move beyond the food producers to commercial agriculture and the effects become far more profound, since pesticides and fertilisers can be applied more efficiently. In fact pesticides are being designed that only release the pest-killing properties when they are inside the target insect and fields can be monitored on a very precise basis.

Philips – finding grains of salt in Olympic sized swimming pools!

Although Phillips is primarily known for its consumer electronics and latterly it's lighting, it is in its medical division that Phillips is primarily making use of Nanotechnology to enhance its diagnostic products and imaging products. One of the most exciting applications is a heart disease testing kit that functions very much like a diabetes self-test. Once commercialized, this will allow the user to prick their finger, place the resultant drop of blood on a disposable test strip and insert this into a hand-held reader. Until now the sensitivity required made this impossible, but the precision of Nanotechnology changes all this. Similarly, the so-called 'lab-on-a-chip' embeds chemical process in a chip which enables the detection and identification of viruses or bacteria causing infection in a much reduced time. Detecting very small things such as tumours is just one half of the story, however, as such small tumours can be very difficult to see. Nanotechnology also provides part of a solution to this problem by enabling a glow in the dark test to be conducted at the same time as being small enough to circulate in the blood stream. To get an idea of the scale and precision of this imaging technology, it's the equivalent of identifying a grain of salt in an Olympic sized swimming pool.



Source: Philips

The impact on the poor could be very positive, but then again the same was said of the so-called Green Revolution which it was said could solve world hunger by increased yields. Predictably, vested interests,

inappropriate application of technology and political masters dictated that the Green revolution was an utter failure in lifting people out of poverty. The same could happen to the hopes for Nanotechnology with an increased divide between rich and poor, but there again it could realise widespread benefits for the poor that include:

Morph – Vision of the future



Source: Nokia

Nokia is a household name by virtue of its mobile handsets, but the mobile looks set to become much more than a phone. In ground-breaking research with Cambridge University, Nokia has set out its vision of the mobile future in the form of Morph – its name for a future device that combines a cellular network with an environmental sensor. The device uses the properties of different materials to combine the best features of each and its elasticity allows it to be worn on the wrist, opened out in to a keyboard, used as a phone or moulded around an object as a sensor. For example, Morph can be used to sense whether an apple is fresh or not, or whether we need to wash it. In a similar vein it can analyse air pollution, and it can download information from the internet on a particular product just by scanning the device over the object and then searching for online information. It can also be used as a phone, and a 'green' one at that - it is biodegradable, solar powered and self-cleaning.

- Renewable energy – reducing energy shortages and the impact of forest fires
- Soil fertility – could be increased reducing malnutrition (but could also increase dependence as per the Green revolution)
- Water treatment – increase supply of cheap, potable water for consumption and irrigation
- Disease diagnosis – inexpensive hand-held kits
- Drug delivery – longer-lasting drugs for hostile environments

Its clear, therefore, that Nanotechnology offers many and varied benefits, but there are significant and potentially far-reaching dangers. Industry has a tendency to commercialise first and answer questions later, although the experience of genetic modification and the public backlash has led to realisation that it is preferable to take the public with you in commercialising new technologies, or they might throw out the good with the bad if sentiment turns against the industry. Agricultural companies are keenly aware of this, as is the Government, who have commissioned research in to Nanotechnology and the dangers involved. In considering these it is necessary to have a little understanding of the technology involved. This broadly falls in to two categories:

- a) Top down – Production of nanomaterials from larger structures where nanoparticles are fixed in the material
- b) Bottom up – production of materials on an atom-by-atom or molecule-by-molecule basis, where nanoparticles may be free of the material.

It is widely regarded that most of the dangers fall in to the second category of deliberately manufactured nanoparticles, which might penetrate cells or cross natural barriers. Such particles are currently limited to

laboratories and cosmetics, but this is likely to change as the technology develops. We are already exposed to naturally occurring nanoparticles such as occur in forest fires, but the scale of intentionally produced nanoparticles is a real cause for concern in the future. Carbon nanotubes have similar characteristics to asbestos fibres and the cumulative, chronic and long-term nature of the risks make the potential for disaster pretty incalculable. The insurance industry doesn't yet have any exclusions on Nanotechnology and with causality being difficult to establish, it's likely to prove a rather fraught and intractable issue for the industry.

Applied Materials



Source: Applied Materials

The cost of solar energy is largely dictated by that of silicon, so any reduction in the amount of silicon necessary to generate a given amount of energy has a direct impact on the cost and therefore viability, of solar energy.

Nanotechnology enables Applied Materials to use a very thin film of silicon, which it spreads on glass plates, and this can reduce the amount of silicon used per Watt of energy by a factor of one hundred, which should lead to a radical decrease in the cost of solar energy.

As with many technologies, the opportunities and threats stem from the same characteristics. For example, enhanced remote sensing may lead to greater safety and personalised healthcare, but it can also be used for covert surveillance. Similarly, military applications involve both offence and defence. Furthermore, many applications are somewhat 'frivolous' yet may carry a significant risk, whilst research in to the risks has failed to keep pace with commercialisation of the technology. There is virtually no information on the impact on species other than humans or indeed on the environment., and research into cosmetic nanoparticles entering the skin has both been insufficient and industry led rather than truly independent.

The latter raises important questions that are common to any new technology; that is:

- Who controls the technology?
- Who benefits?

These are the questions that were addressed by participants in a responsible benchmarking project for the nano industry. Standards will be formalised in 2009, but the draft code includes the following:

- Engagement – with business partners and other stakeholders
- Accountability - at board level
- Risk Assessment – of public and worker health and safety throughout the lifecycle of the products
- Transparency and Disclosure – in research and management of Nanotechnology



The technology innovation division of Headwaters is focused on atomic scale engineering and 'green' chemistry. By using Nanotechnology the company has developed catalysts that generate little or no waste, that have a longer life and use less resources. In the field of pharmaceuticals, there is a need for pure ingredients and in this respect; Nanotechnology enables the production of stable, re-usable catalysts with a reduced risk of contamination. The company is also developing novel materials with properties such as anti-microbial coatings, self-cleaning and environmental controls.

Companies can then be benchmarked against the code, with assessments being made with the help of examples of best practice. These are detailed at www.responsiblenanocode.org, and similarly, the Woodrow Wilson International Centre for Scholars has developed an online database of Nanotechnologies (www.nanotechproject.org), assessing risks against the potential benefits. However, our experience is that most companies make a very cursory reference to safety with regard to Nanotechnology, with very little in the way of substantive evidence to back up any claims. This may be because they haven't felt under any pressure to do so and this would agree with the conclusions of a public Nanojury funded by Greenpeace and Cambridge University (www.nanojury.org.uk) which broadly welcomed Nanotechnology whilst calling for better labelling, testing and access to information. We therefore welcome the Code which should help to remedy the situation as businesses vie with each other to demonstrate best practice.

In conclusion, Nanotechnology looks set to become an everyday part of our lives in many different ways. The increased precision and the ability to alter the properties of materials offers exciting possibilities with key environmental and social benefits, but like all technologies it carries risks and companies tend to let commercial opportunities run ahead of public safety issues. At the present moment in time, we welcome innovations which result in appreciable advances in energy management, resource efficiency and public health, but we are wary of applications where the risk/benefit ratio is less attractive as is the case for cosmetic applications.

About Ethical Money

Ethical Money is at the forefront of developing and promoting new and innovative investment funds which deliver '3D returns'. We work with major investment institutions and private clients, providing investment research, as well helping to develop and promote investments with a high social impact. Our ethical commitment is borne out by being one of the first companies to be awarded the prestigious [Ethics Mark](#).

John Fleetwood founded Ethical Money and has been advising on ethical investments since 1991. He also jointly developed Ethical Analyst, the ethical analysis software for financial advisers, and founded the [Ethical](#)



[Investment Association](#), the industry body for ethical financial advisers. John is Ethical Funds Development Manager at [King & Shaxson](#), a specialist manager of distinctive ethical funds and portfolios. He is also the author of '[The Money Test](#)', the first UK book on Christian financial planning.

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