It is a manipulative and an enabling technology. The subject of a recent work of fiction, it is invisible to the naked eye, and yet a pot of aluminium particles sitting on an executive desk contains enough to give a teaspoonful to every man, woman and child on the planet. And the more you investigate, the more you appreciate that there is …

…very little to it



Dr Paul Reip, CEO of QinetiQ Nanomaterials in the UK, describes his passion as 'dealing with the atoms on the face of the atom', and that passion was self-evident during his presentation to *World Sports Activewear's* The Summit conference in May of last year. Author Michael Crichton has, so some say, outdone his 'Jurassic Park' thriller with, 'Prey', the tale of a swarm of rogue micro-particles infesting the air over a desert in Nevada. Somewhere between the two lies the capacity for mankind to harness the potential of nano materials and devices to enable us to rapidly change the face of many areas of existing manufacturing and service industries.

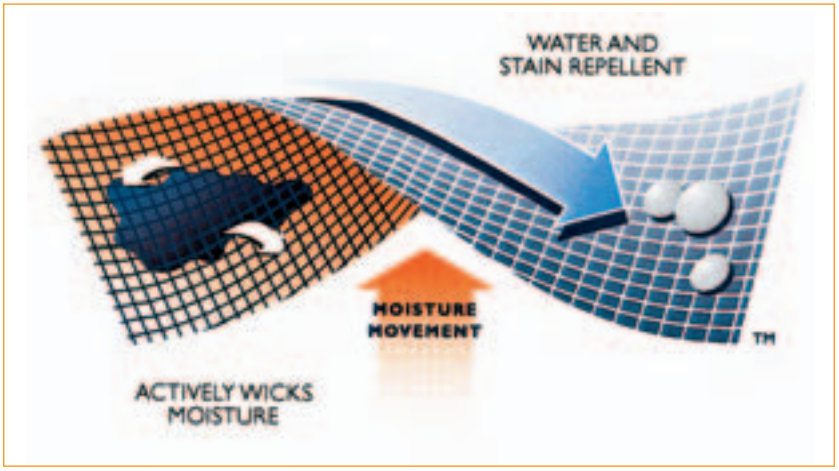
During the last decade the potential in nanotechnology has been recognised and accepted and it has led to a rapid increase in investment from venture capitalists, industry and governments. What it lacks, as Paul Reip will tell you at the drop of a hat, is the 'killer' application – the 'mobile telephone' in the world of nano.

Nanotechnology refers to the ability to manipulate individual atoms and molecules, making it possible to build machines using molecular blocks – or create materials and structures from the bottom upwards. It relates to materials, devices or systems that operate at the nano level, i.e. 10^{9}m.

Business and governments are pouring trillions of dollars (the US government's contribution in 2002 was in the order of $742million) into the possibility that there is a disruptive technology with real industrial relevance lurking below the surface that is being presented. An American writer has suggested that the first ten years of the new century may well be remembered as the "Alice in Wonderland" decade for a new technology. More and more business operations are being established to build on to the research from the previous twenty years that has led to relatively simple methods of manipulation at the molecular level, so that even the most day-to-day substances can be adjusted to behave in unexpected - and often useful - ways. The basic chemical structures of materials in this microscopic landscape remain unchanged, but when materials exhibit surprising properties, they are shaped by the unfamiliar forces of quantum physics, which governs the behaviour of individual atoms. Silicon, for example, becomes fluorescent. Other materials show unusual electrical qualities or become amazingly strong. Recent developments in the use of silver as a bactericide in intimate clothing are bringing us closer to molecular manipulation, but the benefit in using nanotechnology to achieve closer harmony between metal and fibres to improve effectiveness and longevity is currently incalculable.

Primitive forms of nanoscale technology have been used for decades in the sports and active leisure industry. For example, the polyurethane coatings associated with early polymer waterproofing techniques operate at the molecular level – the technicians just use the nano-equivalent of several sledgehammers to bring coating and fabric together.

Today, a growing number of companies specialising in nanomaterials are developing market niches creating customised molecules to embed in other materials. Within the familiarity of sports apparel possibly the most well known products are those produced by Nano-Tex LLC, an operating division of Burlington Worldwide. Nano-Pel, Nano-Dry and Nano-Touch are almost self-explanatory names, but they represent significant advances in the ways we repel dirt and water, transfer moisture from inside to outside and enhance fabric handle.



Nano-Tex's specially engineered fabric system combining the water and stain repellency of Nano-Pel (shown in blue) with the moisture management technology of Nano-Dry (orange).

Another nanoscale segment that is beginning to mature commercially centres on quantum dots, the name given to nanoscale crystals that produce light when stimulated by light or other energy. The size of the dot determines the colour of the light it emits. Although primarily capable of producing benefits for biological research, Nanoco, a spin-off from the Manchester University in the UK, recently began shipping quantum-dot materials to companies that want to build probes and sensors for applications in other areas. In the very near future the company expects quantum dots to be used to make multi-coloured atomic-scale labels for security applications and for sensing hydrogen flows in fuel cells. The latter is similar technology to that reported earlier in *World Sports Activewear,* Summer 2002, regarding clothing and biometrics.

Manufacturers such as 3M have introduced paper-thin films made from nanoscale crystals with filtering properties for displays that are built up from as many as 100 layers of light-filtering and brightness-enhancing materials. The thickness of each layer is controlled to within a few nanometers. Now, to a previously unimaginable degree, manufacturers are tuning the molecular structures in the layers in optical films. Because of quantum forces, they assemble themselves into precise rows and a number of companies are planning to use thin films in displays for products such as screens for hand-held computers.

Paul Reip of QinetiQ is sceptical, despite all the advances made, but many researchers say that thin films and hand-held computers are just the prelude to the main event: the development of nanoscale computers. The only hope of continuing the trend to faster, smaller and cheaper computers appears to be inventing a way for molecular-size components to assemble themselves into useful devices. Quantum forces would rule such devices, the hallmark of nanotechnology.

Derryck Draper

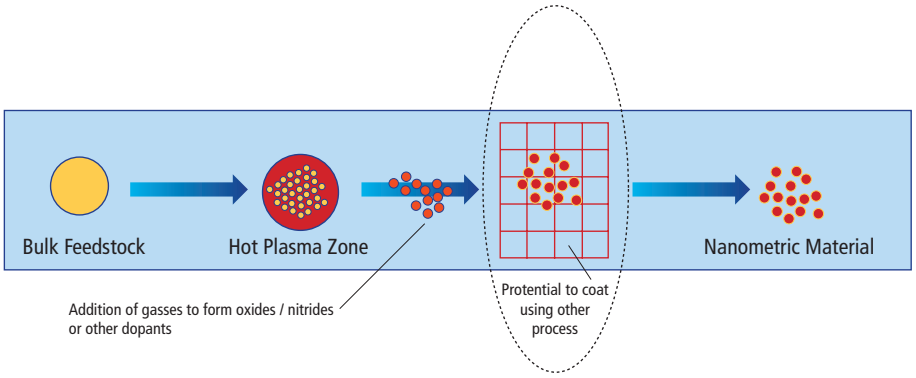


Diagram showing the QNL Process of making nanometric materials using plasma. Materials are vaporised in a hot plasma zone and cooled in a way that controls both the structure and the chemistry of the powders.