Counter-terrorist spray

New electrostatic spray apparatus which could save lives after a terrorist attack involving chemical or biological weapons was to be revealed by Professor Law of the University of Georgia, USA, to this year's Institute of Physics Congress. The apparatus can quickly and effectively decontaminate the skin without producing lots of contaminated waste.

The equipment is based on an electrostatic system that sprays a fine, atomised mist carrying decontaminating compounds, such as an antitoxins, disinfectants, or sanitizers, on to bare skin. The mist penetrates every crevice, the tiny droplets have what Professor Law described as "adequate residual aerodynamic energy to convey and penetrate the electrified droplets into Faraday-shielded regions." In other words, the droplets get on to the skin of the armpit and groin areas.

Electrostatic spraying has been used in industry to ensure an even and complete coating of paint and coloured powders on manufactured goods, such as cars, and in agriculture to make sure pest-control chemicals cover a crop. Professor Law and his colleagues have previously developed improved electrostatic spraying systems for industry and agriculture. In the current international political climate, Law was motivated by the need to make a contribution towards protecting people, both civilians and the armed forces, exposed to biological and chemical weapons.

The apparatus takes the form of a walk-through booth with several microprocessor-controlled nozzles. The nozzles are electrically wired so that the droplets of decontaminant solution spraying out are electrostatically charged and so stick to the skin of anyone standing in their path. Professor Law said 90 people an hour can be sprayed head to foot with 100 millilitres each of decontaminating spray. Only about 20 millilitres per spraying is wasted.

Tests on mannequin and human subjects with innocuous bacteria put on their skin has demonstrated how effective the portable apparatus is in covering the person with antibacterial spray, said Professor Law. "Our apparatus was about fifty times better at decontaminating than other methods using uncharged spray."

"An important feature retained in our engineering design is mobility, the booth is not restricted to hospital use, and provides relatively high human 'throughput' for protective treatment," he added.

Photonic Crystals in 3-D

Telecoms systems contain an awkward mixture of optics and electronics. A purely optical system would permit the very high data rates needed by the Internet, but at the moment the switching and routing, as well as the "last mile" to the customer, still depend on slower electronic components. Speaking at the Institute of Physics Congress, Professor Robert Denning from Oxford University was to explain how his novel holographic approach to making 3-dimensional photonics crystals could allow optical components to be built that remove this bottleneck.

Professor Denning said: "By analogy with electronics the complex optical systems required are called 'photonics', because they use photons in place of electrons but, because it is much harder to control the flow of light than an electrical current, their development has been slow." The outlook has recently been transformed by the invention of a new type of device, the photonic crystal. This acts like an optical insulator, and allows the components that handle optical data to be reduced to microscopic sizes. They can then be densely packaged like electronic circuits in a silicon chip. Unfortunately, the methods used for making electronic chips are not well suited to these new devices. Current manufacturing techniques can only create devices featuring 2-dimensional photonic crystals. However Professor Denning and Professor Turberfield, from the Chemistry and Physics Departments in Oxford, have now found a simple way of using a laser to make the perfectly regular microscopic patterns that are required for 3-dimensional photonic crystals.

Professor Denning said: "2-dimensional photonic crystal structures are easier to make, but diffraction at the edges of the holes that form the pattern leads to the loss of some light. Although this can be made quite small, it cannot be removed completely. In a 3-dimensional structure, confinement of the light is omnidirectional, so no losses can occur. Defining waveguides and cavities within a 3-dimensional structure makes much larger component densities possible, just like the advantage of a multilayer circuitboard over a single layer one." The team uses holographic lithography to make the 3-dimensional photonic crystals. “Holograms are usually made by making two beams of light interfere with each other and then storing the resultant intensity pattern via a light induced chemical change in some medium, photographic film for example. The holographic lithography is just a fancy name for defining the pattern of the photonic crystal via the intensity variations caused when four laser beams interfere. The trick is to find the right chemical reactions to make this possible."