Advanced materials company goes ballistic

UK-based D3O, which develops commercial applications using an advanced foam-like material, is finally moving into the ballistic protection market.

The company has already commercialised its technology in a range of sporting goods applications, and new products including gloves and shoes for cricket, motorcycling and rugby are due to hit stores in 2007.

But D3O has had to bow to market demands, says CEO Richard Palmer: 'We've just begun looking at ballistic protection applications. We've pushed away the ballistic market for so long, but there is so much interest now that we can't keep it away any longer.'

Palmer reveals that D3O has had interest from between five and 10 ballistic protection companies. 'There's quite a lot of work involved in developing these applications, and we need a partner,' he explains. 'For example, we don't have ballistic testing facilities.'

Palmer says that he's close to finalising who D3O will work with, and should have more to announce by the end of 2006. Discussions are ongoing with two US companies, and if things work out there, D3O will work with one of those exclusively.

The reason for such interest is the nanoscale bond in the material, which is sensitive to the speed at which it is deformed. The material acts as a liquid at normal movements, but behaves as an elastomer at high rates of movement.

This means that when used in body armour, on ballistic impact the material would offer both shock spreading and absorption.

'We've done some ballistic testing, and we've had some exciting results,' says Palmer. 'We'll be looking at developing not only body armour but knee plates and shoulder protection that can be incorporated into uniforms and clothing.

Click here for more about D3O

How body armour works

There are two main requirements for ballistic protection, as Richard Palmer explains. 'The first is penetration resistance, which conventionally comes principally from anti-ballistic fibres, such as Kevlar.' This is what stops the bullet getting through, but for defence against high-velocity rifle rounds, fibres aren't enough – ceramic plates are used instead.

'The second requirement is protection against backface deformation,' says Palmer. This is the amount of impact done behind the bullet strike. Smaller backface deformation means less trauma suffered as a result of the shot. 'Even if you've got body armour on, you can still easily get a broken rib from the impact,' says Palmer.

Waterproof nanocoatings in testing for drywalls

Scientists at Case University in the US are testing Ecology Coatings' waterproof nanotechnology with drywalls.

The university is evaluating how effective the coating is at eliminating not only normal mould, in which Ecology has obtained good internal results, but at dealing with toxic mould that endangers children.

'They've had our materials for about two months, and we've had no final results yet,' says Sally Ramsey, chief chemist at Ecology Coatings, which is based in Ohio. 'They are doing tests to make sure the material is safe, and as a green company we're always concerned about that.'

Drywalls, composed of gypsum with a paper coating, are used internally in buildings to separate rooms. If the walls get damp, due to flooding, then problems can result.

'Even if it's not full flooding – perhaps only an inch or two – the water seeps up into the gypsum, which becomes damp, and can penetrate through to the paper coating.'

This can result in toxic black mould spores growing on the paper coating. Ecology's solution is designed to help protect the back or front, or both sides of the drywall, so that the water doesn't get into the gypsum or, if it does, that it doesn't penetrate into the paper coating.

'Toxic mould primarily affects children and old people,' explains Ramsey, 'so it's the paediatric department at the university that is carrying out the tests, using grant money.'

Click here for more about Ecology Coatings

Anti-ice nanocoatings in development

Canada-based CG^2 Nanocoatings is targeting the wind turbine sector with its anti-ice nanocoating.

'If these turbines get iced up, they need to use some of the energy they generate to melt the ice, which reduces their efficiency,' says Amlan Gupta, CEO.

Toxic mould

Health risks associated with mould exposure include, but are not limited to:

- Allergic reactions
- Irritation associated with volatile organic compounds
- Invasive disease
- Mycotoxicosis

According to a 1999 Mayo Clinic Study, nearly all chronic sinus infections (afflicting 37 million Americans) are a result of moulds. A 300% increase in the asthma rate over the past 20 years has been linked to moulds. (according to 1999 USA Today Cover Story).

Source: Toxic Black Mold Information Center

'Even if our coating didn't prevent ice build-up totally, it would reduce the energy and the cost needed to melt it.'

CG2 has had the nanomaterial coatings tested at an independent laboratory, the Anti-Icing Materials International Laboratory (AMIL), where a centrifuge adhesion test was carried out.

Gupta says that the idea for using the coatings on wind farms arose during discussions with the scientists at AMIL.

'The lab found a reduction factor in the adhesion between the ice and the underlying material,' says Gupta. 'It took four times less work to remove the ice with our coating technology.'Another advantage of the coating is that it would be relatively cheap. Gupta estimates it would cost around $100 (€78) for an imperial gallon, compared with other solutions that cost several hundred dollars per litre.

Gupta says that the coating would need to be integrated with the substrate: 'It wouldn't be good to have it flying off the blades.'

Ultimately it might be possible to use the coatings on car windshields and other similar applications, but at the moment the coating is more translucent than transparent. CG2 first started work on the anti-ice coating with aircraft applications in mind – both Gupta and his brother are qualified pilots.

Click here for more about CG2 Nanocoatings

AMIL's single centrifuge adhesion test

A single test series consists of the ice adhesion measurement of three small aluminium beams covered with the candidate product, compared with three bare beams. The extremity of the six sample beams are iced with freezing precipitation to a thickness of around 7mm. Each sample beam is rotated and balanced in the centrifuge apparatus.

The rotation speed increases with a constant acceleration rate until the centrifugal force resulting from rotation reaches the adhesion stress of ice, detaching the ice. This detachment is picked up by piezoelectric cells sensitive to vibrations of the vat which relay their signal in real time to a computer. Finally the adhesion stress is calculated using detachment speed, the mass and the ice surface and the beam length.

The Adhesion Reduction Factor, ARF is then calculated using the average stress measured on the three coated beams compared to the average stress measured on the three bare beams.

Source: Anti-icing Materials International Laboratory

Microwave invisibility shield breakthrough attracts interest

Scientists at Duke University in the US have succeeded in creating a microwave invisibility cloak using metamaterials, paving the way for more advanced devices.

Although the microwave cloak uses micro rather than truly nanotechnology, the team now plans to work on invisibility cloaks for higher frequencies in the EM spectrum, which will require nano-engineering.

David Schurig, who is part of the research team, says that the technology should theoretically work well in three dimensions, and could potentially be used in stealth applications, to prevent aircraft being seen by radar.

'Traditional stealth technology aims to eliminate back-scatter,' explains Schurig. 'But what it doesn't eliminate is the shadow, which can be seen by ambient EM or two-point radar systems.'

The metamaterial technology would eliminate both back-scatter and shadow, rendering the aircraft invisible to all radar. Schurig says that there has been a degree of interest in the microwave technology at state level.

'But the outside of aircraft is very demanding on materials,' says Schurig. 'There are lots of requirements such as aerodynamics and thermal resistance, so we couldn't just stick our technology on the outside – that's a way off.'

Schurig says that it would be easier to put the material onto something with a smooth shape – like a blimp, or on a non-flying vehicle, building or asset.

The work was carried out by David Smith and Schurig in collaboration with John Pendry at Imperial College, London.

'We used coordinate transformation theory to design the microwave cloak, and metamaterials to implement the design,' says Schurig. 'The cloak is a relatively thick, rigid shell around the hidden object, and operates only in a two dimensional environment. We chose to work in two dimensions since the fabrication and measurements are easier there, but the basic physics would be the same in three dimensions'

'The properties these materials need is very advanced,' says Schurig. 'Before metamaterials – about five or six years ago – there was really no way to implement the material spectrum needed for transformation optic theory.

'If you had an application in mind, you could build a product in five to 10 years.'

Click here for more about Duke University

Invisibility cloaking

David Smith's research group at Duke University is pursuing the goal of an invisibility cloak, made using metamaterials. Professor Smith outlines some of the challenges his team face on his website.

'An ideal cloak would absorb no light whatsoever, since whatever amount of light is not transmitted by an object can be a signature that the object is present. The artificial materials that we can currently imagine using tend to absorb a significant amount of light that passes through them, and this presents a very serious limitation that will ultimately set the size of any object to be cloaked.'