

It's what every superhero, from Marvel comics right back to the Greek myths, would have wished for – the invincibility of invisible body armour. d3o unlocks new technology that gives instant protection against impact and yet at all other times is so light and flexible that it's hardly noticeable.

Your flexible protector



A UK research and development company has produced a new material that gives a whole new meaning to body armour as used by those who pursue sports that carry distinct risk of impact injury. Conventional wisdom dictates that to do its job properly, body armour needs to be hard enough to protect the wearer against the impacts that he or she is likely to encounter. The trade-off for such protection has always been restriction of movement, but now d3o Lab has developed a material that, except for the moment of impact, is as flexible and unobtrusive as the wearer's regular sports apparel.

d3o (pronounced dee-three-oh) is described as an 'intelligent' material based on a unique reactive polymer that, when struck, changes its physical state from fluid to solid as the molecules that flow past each other in the suspension lock together. Then, immediately after the crisis is over, the molecules release and the material reverts to its fluid state.

Cometh the hour

To use this polymer as part of a system, the problem has always been that the fluid migrated away from the point of impact when the change occurred and also that the fluid has to be contained somehow. The breakthrough came in 1999 from a young London-based technical innovation consultancy called Design Blue Ltd, which trades as d3o Lab. That was when Dr Phil Green, a materials scientist who had worked in automotive plastics development, was inspired to look again at the technology following a snowboarding accident in the Alps that had left

him nursing an injured elbow. "It occurred to me that all the available impact protection systems work on a macro scale, and because of this they are restrictive, uncomfortable and actually quite ineffective," says Dr Green. "I knew if I could get a system to work at the molecular level we could have an amazing product. Five years of research later we do – d3o," he adds.

In that time Dr. Green, together with co-inventor Richard Palmer, d3o Lab's managing director, have been developing d3o to suit a widening range of applications, backed by UK government funding in the form of a SMART award gained in 2003. The operation has its head office in the OXO tower on London's South Bank and a laboratory in the University of Hertfordshire's innovation centre. There they have been developing two variants of d3o to put the properties of reactive polymers to practical use. The first, d3o flex, is a three-layer sandwich that's designed to cope with extreme ranges of movement. The other is d3o armour, a four-layer formulation that uses ceramic platelets to add extra abrasion and penetration protection in applications where higher level impact protection, is required.

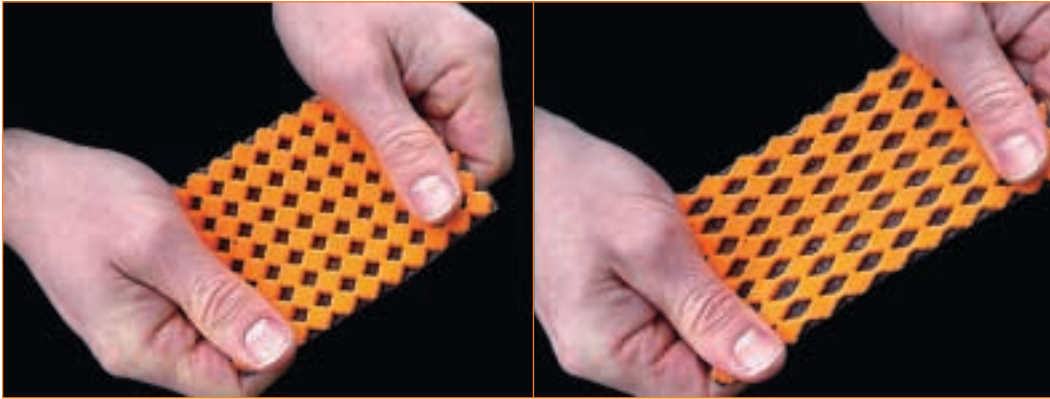
"Dimensions and weights are different according to application, but the flexible properties of d3o will be very similar to the base materials," says Charles Bromilow, d3o's strategy and marketing director. "It's used to back a stretch fabric and our objective is to match the elasticity of the textile. We're working with various textile mills on this."

As to the transformed state of the material when it is struck, Bromilow adds: "When it goes hard on impact it has been engineered to take on

d3o compared to conventional hard shell protection below.

 d3o





D3o believe its Flex fabric not only provides protection but the elasticity and freedom of movement required of extreme sportswear.

 d3o

the characteristics of stiff rubber rather than sheet steel. If the product becomes too rigid it will not absorb any real shock."

Adapted standards

d3o Lab has been able to measure the degree of protection that d3o provides compared with conventional rigid body armour although here, in the absence of official test standards for products such as ski protection, the company has had to adapt tests designed for other applications. "For instance, to measure impact resistance we use a rig that's designed to motorcycle standards," says Charles Bromilow.

At this level a 6mm thick pad of d3o has been shown to outperform a considerably thicker honeycomb and rigid foam panel by a wide margin, Bromilow maintains.

Other properties also add to d3o's appeal. It can be integrated directly into clothing. It is claimed to be light, flexible and far less bulky than solid-foam impact protection so as to allow unrestricted movement. Moreover, it's breathable, washable and, says Charles Bromilow, is unaffected by temperatures "within the usual athletic range." He adds: "The high temperature limitation is still being explored, and low temperatures don't affect d3o's mechanical properties. Even when we immersed it in liquid nitrogen it retained its elasticity."

It's the task of the d3o Lab design team, to identify market opportunities for d3o and generate interest among major sports brands in using d3o technology in their own product lines. Although extreme snow sports and recreational skiing were the inspiration behind d3o and remain a key target market, applications exist in a multitude of other sports such as mountainbiking, cycling, motocross and skate boarding to name but a few.

At present the company is working with a number of brands "to deliver revolutionary clothing with integrated, flexible, comfortable protection," according to Bromilow. Most of the work is still at the prototype stage, although one finished product has already come onto the market, albeit in a niche sector where volumes are small. The company is providing d3o for leather knee guards worn by polo players. These guards, made by Casablanca Polo, are designed to offer

enhanced protection with greater flexibility than the traditional product. "Customers wanted to keep to traditional leather guards, but with better protective performance and thinner leathers for improved mobility," he points out.

Elbow, shoulder and knee pads have been the main applications that d3o Lab has been developing so far, but the company is also working on gloves and footwear. Regarding gloves, it has produced knuckle and finger protection pads to replicate the EVA foam and synthetic rubber of conventional impact protection products. In comparative testing d3o finger pads were shown to be more than six times softer than the conventional synthetic rubber units and yet transmitted 12.4 per cent less impact while the d3o knuckle inserts were five times softer than their EVA counterparts and yet delivered 2.7 times more protection.

Footwear applications

Work on footwear applications is also underway, but at an early stage. Here, the company believes that it can provide a competitive alternative to systems such as those integrated in the adidas 1 trainers that have in-built electronic control to mechanically adjust the amount of cushioning required by the wearer every four steps. The intelligent molecules in d3o do the same job organically, instantly changing the stiffness of the cushioning according to the amount of pressure applied by the wearer's feet. Conventional shock absorbing foams have a constant stiffness when loaded, which means that for footwear they are either too hard when walking or too soft when jumping. There is always a compromise.

Although Casablanca Polo is already marketing d3o-reinforced knee protectors, Bromilow expects that other, higher-volume, products with d3o protection will not be on the market until autumn next year. "The challenge is twofold: taking d3o from small-scale processing into mass production to meet the projected demands, and educating consumers that rigid impact protection is not necessarily the best."

Provided that d3o lives up to its early promise, this technology looks set to transform our ideas about body armour. New applications are likely to arise not only in the world of sport, but some way beyond. 