

Defying gravity

Tom Shelley reports on how research into replicating the means whereby insects adhere to surfaces is progressing.

Studies of how insects and lizards are able to walk on ceilings show that they use effects which are very difficult to fully replicate in mainstream engineering.

However, this has led to a product that insects cannot adhere to, to keep them out of places where they are not wanted, and there are always ways in which adhesives and fasteners can defy gravity that are perfectly practicable, if designers care to embrace them.

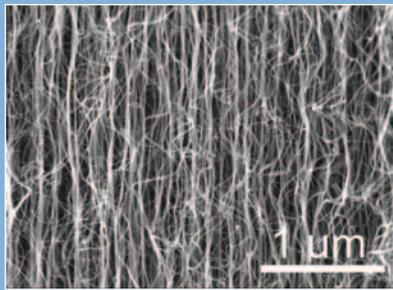
Dr Walter Federle, who heads the Insect Biomechanics Workgroup at the University of Cambridge Department of Zoology, revealed in a seminar that insect and spider adhesion 'outperforms all conventional adhesives'. They can also attach themselves to substrates that are rough and contaminated and even in some cases anti-adhesive, but quickly detach themselves in order that they can walk about. Their secret, he explained, is that they all use wet adhesion and even when they appear to use smooth pads, have additional tiny hairs called tenent setae.

Gecko lizards also use these tiny hairs, which in their case, are not aided by wet adhesive. These work by Van der Waals forces, enhanced by the sizes and shapes of the tips. There have been many attempts to reproduce this behaviour by creating pads of carbon nanotubes, particularly in US universities such as Berkeley, but while these do show the effect, they only function on smooth surfaces and nothing like as well as the geckos.

Insects and spiders do better because they use both hairs and adhesives. Dr Jan-Henning Dirks has noted that the liquid secretions that aid adhesion are emulsions with watery droplets in an oil phase, only nanometres thick. The emulsions have non-Newtonian properties that combine the benefits of wet adhesion and resistance against shear forces. Using this mechanism, a single insect foot can in some cases support 20 times body weight. Insect feet

DESIGN POINTERS

- Insects adhere to walls and ceilings using fine hairs and a special, natural water in oil based emulsion adhesive, nm thick



- While it has not so far been possible to reproduce this attachment system, it has been found possible to stop it, coming up with an eco friendly way of keeping insects out of places where they are not wanted
- Other ways of defying gravity with fasteners and adhesives continue to be commercially available



are designed to ensure good adhesion when feet are placed on the surface, but allow peeling off with a push from the heel when it is time to detach.

While reproducing insect adhesives is yet to be achieved, Dr Dirks and a colleague have come up with a surface to which insect feet cannot adhere called InsectiSlide, which can be used in tape form and is patent applied for. It works by absorbing the watery phase, leaving only the oily phase for insect feet to slip on. Applications include preventing insect entry to buildings, clean rooms and electrical, electronic and mechanical products. Current features are said to be based on an easily available commodity polymer that is cured on any surface, although the patent covers the general principle of how it works rather than any particular formulation. The product is said to be non toxic, eco-friendly, durable, cleanable and weatherproof.

However, if one still needs to defy gravity and cannot wait for the perfect attachment system, there are plenty of commercial ways of doing this. Thixotropic adhesives that can be sprayed or brushed on but don't run down or drip are available commercially from all the usual suppliers. If something is to be attached mechanically to an overhead or vertical surface, TR Fastenings can custom design special fasteners for almost any application, and recently came up with a design of standoff rivet bushes for sheet metal specialist Potters. Much can also be done to overcome gravity using springs, and Southco has just come out with new ST-12C spring counterbalanced hinges which are specified to stay with +20% of rated torque for 20,000 cycles of operation.

www.zoo.cam.ac.uk/zoostaff/federle/

www.insectislide.com

www.trfastenings.com

www.southco.com