Velcro with little mush

Scientists have developed a material that sticks to a wide range of textiles without doing any damage. The work is done by miniscule 'mushrooms'. Inspiration for the design came from nature.

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In the world of adhesives and fastenings there are various Velcro-like materials that work on the principle of mechanical adhesion, where two surfaces grip each other firmly. A disadvantage of such strong materials is that on removal, they can sometimes damage the surface they are stuck onto.

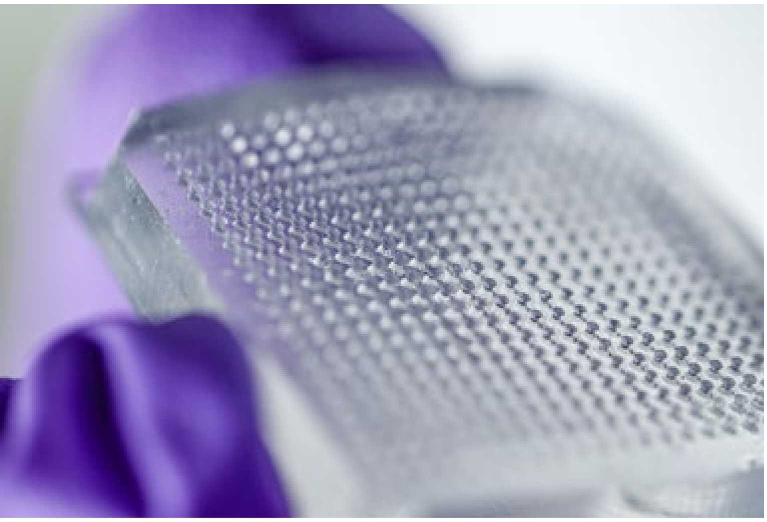
Researchers at the Wageningen chair groups Physical Chemistry and Soft Matter, and Bio-Nano Technology have come up with a solution, in collaboration with colleagues from Groningen. They found inspiration in nature's adhesive mechanisms. The gecko, for example, has a pattern of miniscule pillars under its feet, while in the plant kingdom, cleavers owe their name to tiny hooks on their leaves.

The researchers designed and studied several materials with such protrusions in different patterns, with a view to understanding the fundamental mechanisms underlying adhesion. That resulted in a flexible silicon rubber covered in miniscule mushroom-shaped pillars. When these 'mushrooms' touch rough pliable surfaces such as textiles, they attach themselves firmly by hooking onto the material's mesh. When they are pulled off again, the mushrooms release the fibres gently without damaging the material.

LESS STICKING POWER

The flexibility of the material prevents damage on removal, explains researcher Joshua Dijksman of Physical Chemistry and Soft Matter. 'The closer together the

rooms



Researcher Preeti Sharma demonstrates the sticking power of silicon rubber with mushroom-shaped protrusions.

mushrooms are, the better the adhesion,' he says, 'but at a higher density, the individual sticking power of the mushrooms goes down. And when you pull off a single mushroom, you pull off its neighbour too via the flexible surface. The mushrooms influence each other through the surface, communicating with each other.' This phenomenon creates scope for experimentation, says Dijksman. 'It gives you starting points for optimizing a product, depending on the goal of the adhesion.' With a newly developed measuring method, these forces can be measured in a standardized fashion. 'To change the degree of adhesion, you can alter the number of mushrooms or the hardness of the material.'

'To change the adhesiveness, you can alter the number of mushrooms'

The new material works well on rough surfaces. For smoother surfaces, experiments are being conducted with tiny suction cups instead of mushrooms. 'We are studying whether the communication principle applies there too,' says Dijksman.

The production method for the soft 'Velcro' is new too. The cast used to produce the mushroom pattern is 3D-printed. It is then used to create a negative as the basis for a positive, using flexible silicon rubber. A patent for this method is pending.

The research is part of the Dutch 4TU Soft Robotics programme, which aims to produce flexible soft surfaces that can be used in robotics in contexts where a gentle touch is called for, such as in human interaction or in fruit-picking. The results were published in the scientific journal *Biointerphases*. ■

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