News archive

- 2010
  - February 2010
  - January 2010
- 2009
- 2008
- 2007
- 2006
- 2005
- 2004
- 2003
- 2002
- 2001
- 2000
- 1999
- 1998
- 1997

Spider web inspires fibres for industry

Feb 3, 2010 1 comment

Watery trap Spider silk manipulates water with skill

Spiders may not be everybody's idea of natural beauty, but nobody can deny the artistry in the webs that they spin, especially when decorated with water baubles in the morning dew. Inspired by this spectacle, a group of researchers in China has mimicked the structural properties of spider webs in creating a fibre for industry that can manipulate water with the same skill and efficiency.

Lei Jiang of the Chinese Academy of Sciences set out with his colleagues to look at the fine detail of spider webs and the way that the silks interact with moisture in the atmosphere. They found that the water-collecting ability of *Uloborus walckenaerius* – a common, non-venomous spider – is the result of a network of knots that form in the web when it gets wet.

Dotted periodically throughout the web, these structural features create gradients of energy and pressure between knots. The result is a sort of cascade whereby moisture condenses from the atmosphere and is then channelled towards these spindle knots. As a result, drops of water as big as 100 µm in diameter can form.

Web knots

Individual knots begin to form when tiny water droplets condense at certain sites or "puffs" in the spider silk. Using Scanning Electron Microscopy (SEM), the researchers found that at these sites, known as "puffs", the nanofibrils that comprise the silk are no longer aligned but point in random directions.

Armed with this knowledge, Jiang's team then replicated the spider fibres using polymethyl methacrylate, a synthetic polymer that was chosen because it bonds well with water molecules. The major technical challenge was to fine-tune these fibres to function in realistic industrial conditions whereby temperatures and humidity levels are often changing. They succeeded in creating individual fibres that could trap and transport water droplets in the same way as the spider silk.

The researchers are unsure of why the spider has evolved to possess this ability. "It could be for its drinking activities, or it could be to refresh the web structure to make it stronger and stickier for prey," Jiang told *physicsworld.com*.

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Smart catalysis

Mato Knez at the Max Planck Institute of Microstructure Physics, who is also interested in industrial applications inspired by spider webs, believes that it could be a tactic to protect the web. "If the water is distributed along the silk as film, this might lead to destruction. However, by allowing the droplets to grow until reaching a critical size they will presumably fall from the silk," he says.

Jiang and his team intend to develop their research by preparing a series of materials that control water in different ways. One application could be "smart catalysis", which can speed up a chemical reaction without needing a catalyst.

Andrew Martin, a bioengineer at Bremen University in Germany, is doubtful that this technology could be useful on a large industrial scale, but he envisages smaller-scale application. "The directionality of water collection might be useful in any rheological or microfluidic process."

This research is published in *Nature*.

About the author

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1

dratman
Feb 7, 2010 6:23 AM
cherry Hill, United States

"The researchers are unsure of why the spider has evolved to possess this ability. 'It could be for its drinking activities, or it could be to refresh the web structure to make it stronger and stickier for prey,' Jiang told physicsworld.com. Mato Knez at the Max Planck Institute of Microstructure Physics, who is also interested in industrial applications inspired by spider webs, believes that it could be a tactic to protect the web."

The above discussion seems to assume that evolution acts like a human designer, first setting out a goal, then synthesizing a design to fulfill those goals.

But Nature doesn't make choices among goals or strategies. If we want to describe Nature as a single actor (which of course it isn't) we must explain that it tries many things at once, then keeps what doesn't fail. Otherwise, Nature would be no better at designing things than we humans are. And, as we all know by now, human designs for the world often don't work out as well as we hope they will.

Edited by dratman on Feb 7, 2010 6:28 AM.

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