A Composite Thread that Varies in Rigidity

EPFL scientists have developed a new type of composite thread that varies in stiffness depending on its temperature. Applications range from multifunctional robots to knitted casts, and even tunable medical devices.

A new type of thread has been developed at EPFL that varies in stiffness depending on its temperature. This new structure could be used in future robots, orthopedics and even medical devices for biopsy. The results are now published online in Advanced Materials.

A drone that integrates these threads of variable stiffness can morph from a flying device into a robotic car : the motors can be used as either propellers or as wheels, depending on their position which can be adjusted thanks to the threads. When knitted, the thread could be used as an electronic cast for rehabilitation of broken joints. A modular biopsy device could be soft for safe exploration of human orifices, and hardened to favor biopsy sampling.

“The amazing flexibility of this new lightweight thread is due to its ingenious simplicity and robustness that makes it easy to manufacture and use in a wide range of applications, shapes, and combinations with other technologies”, says the project director Dario Floreano.

How it works

A silicone tube contains a metal alloy that is solid below 62 degrees Celsius, but that melts at temperatures above. By wrapping the silicone tube with thin conductive wire, the tube can be heated above this threshold temperature by simply injecting current into the wire.

When the tube is heated, the thread is soft, rubbery and stretchable like the silicone tube. But when the thread is cooled below 62 degrees Celsius, the metal core solidifies and the thread becomes solid, becoming over 700 times stiffer and defining its rigid shape. The thread therefore has the ability to vary its stiffness – making it soft and deformable, or stiff and inextensible – depending on its temperature.

The composite thread also has self-healing properties. If the thread, in its solid state, gets cracked, it can self-heal by simply melting the metal core.

For EPFL scientist Alice Tonazzini, this composite material can be further explored for more advanced applications in robotics. Tonazzini says, “We would like to transform our thread into a robotic material that is able to mimic the complex functionalities of biological tissue.”

Along with EPFL, this work comes out of NCCR Robotics, a consortium of 23 robotics laboratories across Switzerland.

Useful links:

Press kit (images, videos): http://bit.ly/2016VariableStiffness
Laboratory of Intelligent Systems http://lis.epfl.ch/

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