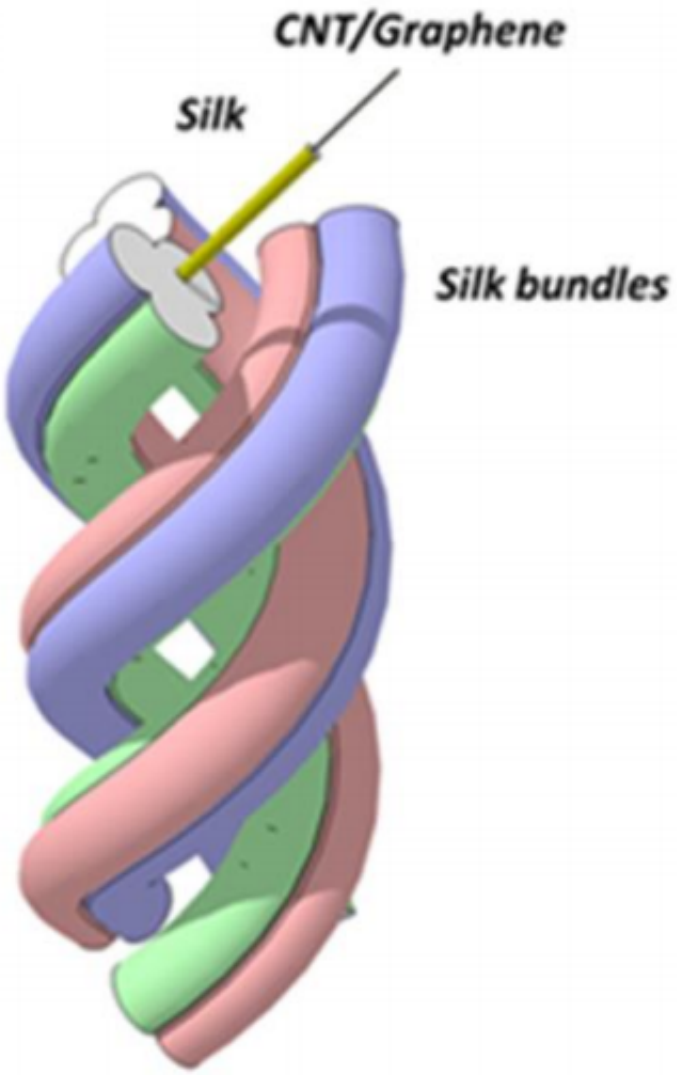
Spiders sprayed with carbon nanotubes spin superstrong webs

May 6 2015, by Bob Yirka



Schematic of the model. Credit: arXiv:1504.06751 [cond-mat.mtrl-sci]

(Phys.org)—A team of researchers working in Italy has found that simply spraying a spider with a carbon nanotube solution can cause the spider to spin stronger webs. In their paper they have uploaded to the preprint server *arXiv*, the team describes their experiments with both graphene and nanotube solutions and what happened when they sprayed it on ordinary spiders.

As the researchers note, while silk production using silkworms has been quite successful, doing the same to harvest silk from spiders has not, (because of their territorial traits, the complex nature of the silk they make and their cannibalistic tendencies) which is frustrating as the silk they make to spin their webs has so many outstanding qualities. Intrigued by prior research efforts that investigated the possibility of enhancing spider silk by spraying the spiders or feeding them different materials (titanium, zinc, aluminum, lead, etc.) to improve the mechanical, electrical, magnetic or even fluorescent properties of the silk, the researchers wondered what would happen if they sprayed the arachnids, with a graphene or carbon nanotube solution.

To find out, they wandered out into the natural environs near their lab and collected a host of cellar spiders and carefully brought them back to their lab. They then proceeded to spray ten of them with a carbon nanotube solution and five with a graphene solution (the particles were 200 to 300 nanometers in width). Sadly, four of the spiders died shortly thereafter, and some produced poor quality webs, but a few of them produced webs that were actually stronger than their normal webs. Testing showed that some of the silk with nanotubes in it was 3.5 times as strong as giant riverine orb spider silk, which is considered the strongest natural spider silk. Also closer examination using Ramen spectroscopy revealed peaks in the silk where the nanotubes were present.

The researchers do not know how the carbon in either form wound up in

the silk, but have excluded the possibility that it became drenched with it as it exited the spider's body, the uniformity of the silk was too fine—they think that the spiders pull materials in from their immediate environment and use it as an ingredient in their silk making. Their results suggest it should be possible to produce such silk in small quantities, though it is not clear to what use it would be put.

More information: Silk reinforced with graphene or carbon nanotubes spun by spiders, *arXiv*, arXiv:1504.06751 [cond-mat.mtrl-sci] http://arxiv.org/abs/1504.06751

Here, we report the production of silk incorporating graphene and carbon nanotubes directly by spider spinning, after spraying spiders with the corresponding aqueous dispersions. We observe a significant increment of the mechanical properties with respect to the pristine silk, in terms of fracture strength, Young's and toughness moduli. We measure a fracture strength up to 5.4 GPa, a Young's modulus up to 47.8 GPa and a toughness modulus up to 2.1 GPa, or 1567 J/g, which, to the best of our knowledge, is the highest reported to date, even when compared to the current toughest knotted fibres. This approach could be extended to other animals and plants and could lead to a new class of bionic materials for ultimate applications.

via Newscientist