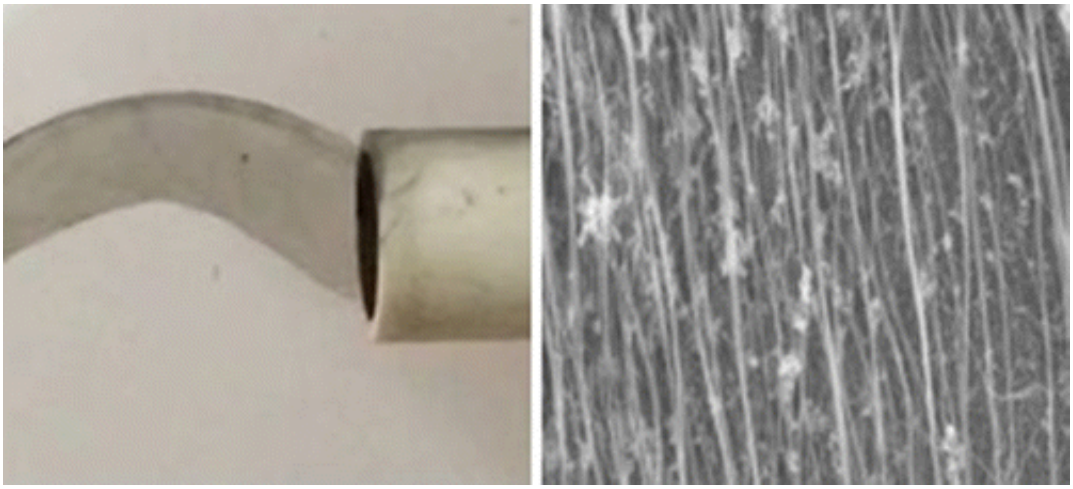
New technique leads to creation of elastic high-strength carbon nanotube film

February 4 2016, by Bob Yirka



(Phys.org)—A new technique developed by researchers at East China University of Science and Technology and Shanghai Jiao Tong University has led to the development of a high-strength carbon nanotube film that retains much of the elasticity of native carbon nanotubes. In their paper published in the journal *Nano Letters,* the team describes their technique and the characteristics of the materials they made.

Ever since researchers discovered that creating sheets made of single layers of carbon atoms grown in a tub shape resulted in a material with exceptional electronic and elastic properties, the search has been on to

find a way to produce a material made of them in bulk, in a way that does not cause them to lose some of their exceptional properties. In this new effort the combined team in China has developed a method that allows for creating such a material while retaining most of its elastic and other properties. The result is a material that looks like a thick black plastic trash bag. But looks can be deceiving, the material has been found to be significantly stronger than both Kevlar and carbon fiber.

Prior attempts to make such a material have left a lot to be desired because they failed to keep the nanotubes aligned in the final product. The new approach overcomes that problem by using nitrogen gas to push single layers of carbon nanotubes along a tube surface inside of a 2,100 degree oven. As the material is removed from the oven, it is wound around a drum and then compressed further by running it through rollers. The result is a material that the team tested at a tensile strength of 9.6 gigapascals, which is approximately five times as strong as any other material made of carbon nanotubes. In contrast, carbon fibers have been tested to 7 gigapascals and Kevlar to just 3.7. As if that were not enough, the material was also shown able to elongate approximately 8 percent, which is far more than the 2 percent for carbon fibers.

The team believes the new material would be suitable for use in wearable devices and possibly in artificial muscles and perhaps as a component in protective clothing for soldiers or athletes.

More information: Wei Xu et al. High-Strength Carbon Nanotube Film from Improving Alignment and Densification, *Nano Letters* (2016). DOI: 10.1021/acs.nanolett.5b03863

Abstract
A new method is reported for preparing carbon nanotube (CNT) films. This method involves the continuous production of a hollow cylindrical CNT assembly and its condensation on a winding drum. The alignment

and densification of CNTs in the film are improved by controlling the winding rate and imposition of mechanical rolling, respectively. The prepared film has a strength of 9.6 GPa, which is well above those for all other man-made films and fibers.