Nanofiber with the Potential to Decrease Smuggling

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Fibers so small, they are practically invisible. This feature led a group of scientists from the University of Puerto Rico at Mayagüez (UPRM) and Cornell University to investigate an innovative application that would reduce smuggling in the textile industry.

The goal is to introduce within that tiny fiber called a nanofiber, a single magnetic signal that could be used as a tool to control the textile inventory, among other uses, said Dr. Carlos Rinaldi, principal investigator of the initiative and a professor of Chemical Engineering.

In technical terms a nanofiber has a diameter less than one micron which is equivalent to one millionth part of a meter. “The advantage of nanofiber is that because of its tiny size, its surface area is very large… There is more area for contact with the fiber and because it is polymeric it can be modified,” said the scientist.

To generate the nanofiber polymer researchers use electrospinning. This process uses an electric field which is formed within two parallel plates. In the upper plate there is a bubble where the polymer, which is a chemical compound whose molecules are formed by the union of smaller molecules, is deposited.

“By applying an electric field, charges accumulate on the surface and these charges lengthen the polymer bubble causing a drip, and thus forming the fiber. When the fiber begins to behave like a whip - this is called whip instability - the polymer stretches and as it stretches it becomes solvent. What is deposited on the surface is a dry fiber with a diameter of between 50 and 500 nanometers,” he explained.

Benefits for the textile industry

During a recent engineering congress researchers from this project, including Rinaldi, the doctoral student from the UPRM, Carola Barrera and Dr. Juan Hinostroza from Cornell University, presented the preliminary findings of the study.

One aspect that they stressed is that due to the trends of globalization the problem of textile smuggling represents a significant economic loss for the industry in the United States.

The scientists pointed out that according to data provided by the Organization for Economic Cooperation and Development of the United Nations, in 2002 smuggling cost the United States approximately $450 billion. This, as confirmed by statistics, resulted in the loss of 17 thousand jobs in that country. For that year, it was estimated that the value of illegal textiles that entered the United States amounted to $2 billion dollars.

Faced with this reality, researchers believe that polymer nanofiber could be a tool to identify textiles before manufacturing the final product. “The fibers would be part of the clothing. They would be mixed with the cotton fibers or other materials used in the manufacture of clothing. The polymer to be used would have to be resistant to usual clothes washing and handling,” said the scientist.

Specialized equipment would be used to scan or read the unique magnetic imprint emitted by the tiny fiber. “It's a signal that can be measured magnetically without destroying or modifying the material, making it easy to implement in anti-smuggling,” he added.

As part of an effort in favor of smuggling reduction, Rinaldi added that in addition to the possible applications of nanofiber in the textile industry, this fiber can

have other utilities such as marking money or passports. This would minimize the effect of money and document forging, he explained.

It also has the potential to be the first step towards the creation of ‘smart clothes’ which adapt to different environmental and personal conditions. “The clothing would respond to a stimulus or could interact with an external system to achieve a result. For example, clothing that monitors vital signs and administers a drug in response to an adverse situation. In the case of magnetic imprint fiber, clothes would interact with a verification system to authenticate the user,” he said.

This research is funded by the National Science Foundation of the United States. Rinaldi expects to have, by the end of this year, a fiber with a reproducible magnetic imprint.

“In all the applications we have in mind, the idea is that nanofibers would be incorporated into the formation of the fibers that make up the fabric. Thus, the anti-smuggling capacity starts from the raw materials: the fibers themselves. That would be the case for passports that have a cover whose raw material is cotton. In the case of money it would be something similar, because the American dollar is made using a mixture of cotton and linen,” Rinaldi said.