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E-Fibers: Sensor Functionality

EMPA
Materials Science & Technology

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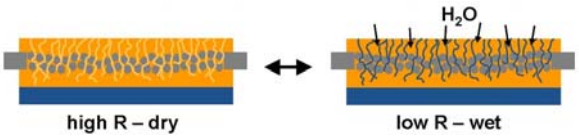
Introduction

The ability to deposit thin conductive coatings with electronic functionality on single polymer fibers (so-called e-fibers) opens the door to many exciting applications in the field of smart textiles, including wearable electronics, sensors and multiple electrode devices. Metal/plasma polymer nanocomposite coatings attract a long-term interest in research due to the great potential to tune their mechanical, electrical and optical properties according to the requirements of any particular application. Conductive polymer coatings have the advantage of being flexible and are able to form smooth, homogenous layers. PEDOT:PSS is particularly interesting because it is sensitive to external conditions, making it an ideal candidate for pressure and humidity sensors.

Ag/C:H:O Nanocomposite Coatings on PET Fibers for Humidity Sensing

A decrease in resistivity can be recorded when the Ag/C:H:O nanocomposite film is exposed to humidity as a response to changes in the metal-containing layer or the polymer matrix of the nanocomposite film.



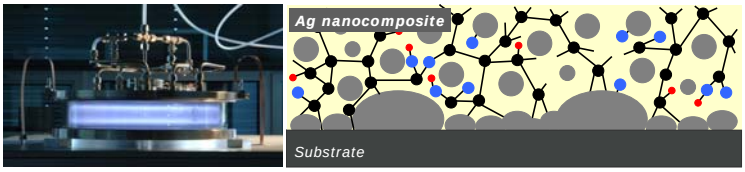
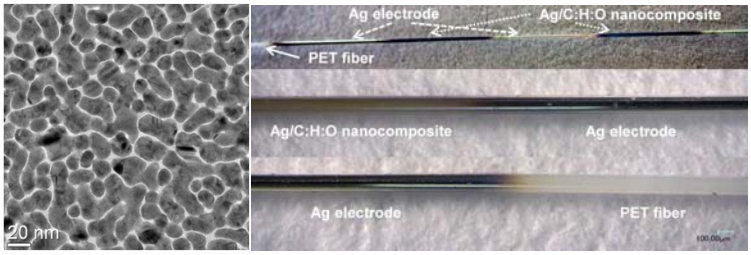
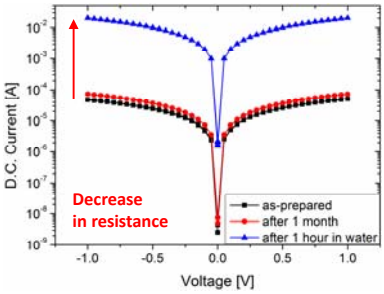


Photo of the vacuum plasma deposition chamber (left). A drawing of a metal/plasma polymer nanocomposite thin film (right).



TEM micrograph of Ag/C:H:O plasma polymer film prepared at RF power of 50 W (left). Vacuum deposition of structured Ag electrodes and Ag/C:H:O nanocomposite coating on monofilament PET textile fibers (right).



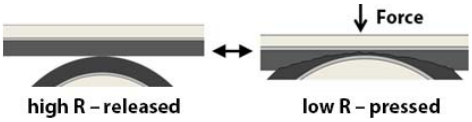
Sheet resistance of films

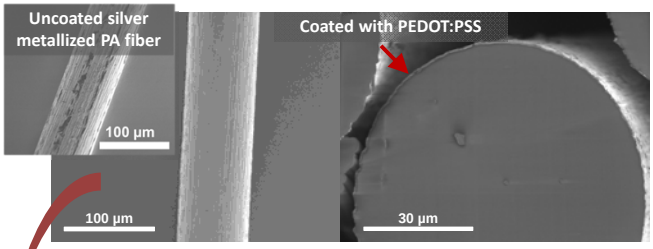
Thin film	R_S [Ω/sq]
as-prepared	$6.0 \cdot 10^4$
after 1 month in air	$4.0 \cdot 10^4$
after 1 hour in water	$2.0 \cdot 10^2$

I-V characteristics of Ag/C:H:O film (20 nm thick) prepared at RF power of 50 W.

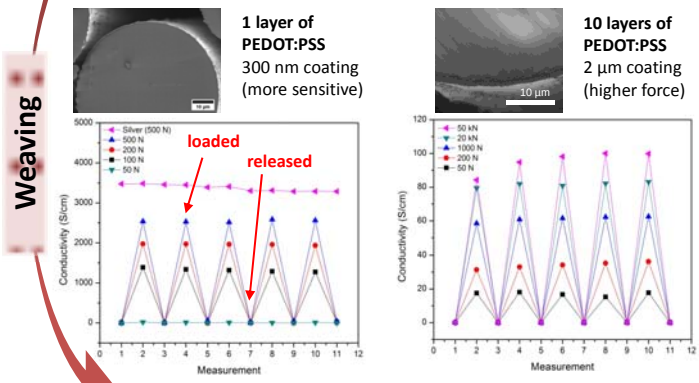
PEDOT:PSS Coatings on Ag-Metallized PA Fibers for Pressure Sensing

A decrease in resistivity can be recorded due to a deformation of PEDOT:PSS film between the two crossed Ag-metallized fibers upon the application of a force as a result of an increased contact area and a shortened distance between Ag layers of the two crossed fibers.

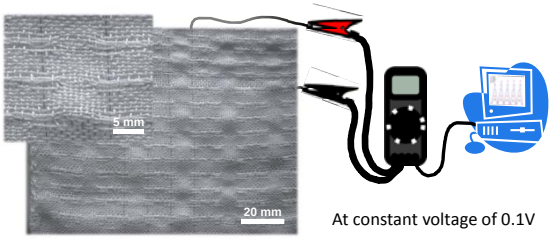




SEM of a homogenous PEDOT:PSS film dip-coated on Ag-metallized PA fibers.



Conductive Textiles – Wearable Pressure Sensors



At constant voltage of 0.1V

Conclusions

A process for making stable, highly conductive PEDOT:PSS coatings on monofilament PA fibers was developed. These extremely flexible e-fibers were then integrated into fabrics and textiles and successfully tested as pressure sensors. Our textiles maintain the feel and the functionality of a traditional material. In the case of Ag/C:H:O plasma polymer nanocomposite coatings, suitable deposition conditions for preparation of films were determined. Monofilament PET fibers were coated in a single-step vacuum deposition process. The functional e-fibers were successfully tested as humidity sensors.

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