Smart textiles having sensors and actuators to help human activity

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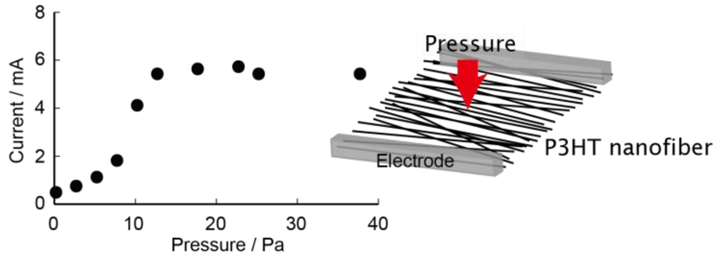
Keywords: Electrospinning, Conductive Polymers, Carbon Nanotubes, Assembly



Biological and artificial materials contain hierarchical structures composed of structural elements possessing different size scales, and the structural hierarchy plays an important role in determining bulk properties. The construction of hierarchical structures based on nano- and microstructures can give rise to improved or more useful physical properties. Recently, several groups have demonstrated flexible skin-like electronic sensors through the creation of ordered structures on flexible substrates. These sensors can detect pressure, strain, and bending changes through the deformation of nano- or microstructures. Assemblies of one-dimensional fibrous structures have also been used as sensing units in the skin-like electronic sensors. The assembly of tiny fibers is a useful microstructure for monitoring minute pressure changes.

Regioregular poly(3-alkylthiophene)s (P3HTs) are the most prominent organic semiconductors applied in organic electronics involving organic field-effect transistors and solar cells. Nano-scaled P3HT fibers have been fabricating using various techniques, such as self-organization in solutions and electrospinning, and their electronic properties have been investigated. Electrospinning is a simple method for producing long and continuous fine fibers with diameters ranging from 10 nm to sub-microns. Because of the absence of chain entanglement of rigid rod-like P3HT in a solution, the continuous spinning of uniform P3HT nanofibers requires either mixing with high-molecular-weight insulating polymers or the use of highly concentrated solutions. The mixing of conductive P3HT with nonconductive polymers has resulted in a lower conductivity compared to pure P3HT. To avoid this drawback, core-shell nanofibers embedding P3HT nanofibers have been fabricated by coaxial electrospinning using sacrificial shells. To obtain the pure P3HT nanofibers, the shell layers needed to be removed from the core-shell nanofibers, and the residual shell layers around the P3HT nanofibers affected the electronic property. To overcome this limitation of pure P3HT nanofiber fabrication, we used a high-molecular-weight regioregular P3HT. The molecular weight of this P3HT is about 10 times higher than that of the P3HT used in previous studies.

In this presentation, I will describe a simple approach for fabricating scalable flexible tactile sensors using a nanofiber assembly of regioregular poly(3-hexylthiophene) (P3HT) and an elastic fiber coated with carbon nanotubes. Small physical inputs into the self-standing P3HT nanofiber assemblies give rise to additional contact among neighboring nanofibers, which results in a decreased contact resistance in the directions orthogonal to the nanofiber orientation. The P3HT nanofiber assemblies could detect pressure changes and bending angles by monitoring the resistance changes, and the sensor responses were repeatable.