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Editorial corner – a personal view

Electro-active polymers for wearable energy harvesting applications

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With the advent of the Internet of Things (IoT), smart connected objects implementing numerous sensors and complex diagnosis/communication accessories are multiplying. Their power supply requires renewable electrical power generation systems adapted to miniaturized low-amperage batteries of wearable electronic devices. Thus, new energy sources are needed in order to gain autonomy without compromising performance. A solution is to develop energy harvesters based on piezoelectric materials having the ability to convert cyclic mechanical stresses (torsions, bending, compressions…) into electrical energy usable to power sensors and accessories. Such energy harvesting devices are particularly suited to the nomadic production of electrical energy so as to increase the autonomy of 'wearables', providing they can be miniaturized, flexible and even transparent. They are currently made from piezoelectric ceramics. Satisfactory efficiency can be achieved with complex architectures. However, their miniaturization is tricky due to the complex processing of ceramic structures.

The increasing demand for flexible, translucent or transparent smart devices thus opens up an interesting field of application for electro-active polymers, in particular piezoelectric polymers, whose shaping by standard plastics processing and 3D printing technologies is relatively easy compared to ceramics. Although piezoelectric coefficients of polymers are low compared to those of ceramics, they are enough for the design and manufacture of miniature flexible energy harvesters that can be integrated into wearable connected devices.

For example, 3D printing makes it possible to design extremely complex architectures and, in particular, interpenetrated architectures of P(VDF-TrFE) copolymer and adhesive electrodes made of electrically conductive polymers (PMMA/carbon nanotubes nanocomposites or PEDOT/PSS). At the same time, research is being carried out to overcome the PVDF (beta form) – currently the most efficient piezoelectric polymer – processing difficulties which generate additional costs that still penalize its large-scale exploitation. Blending polymers (e.g. PVDF/PMMA) appears to be a promising way to get at a lower cost, by avoiding several processing steps, the piezoelectric form of PVDF directly by extrusion. From a sustainable development viewpoint, biobased solutions (PA11, PLA) are also being investigated.

Thus plastics industry is at the forefront for the development of future generations of smart connected objects and clothing-integrated wearable electronics.

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