content. Furthermore, the researchers demonstrated that the basic design can be suitably adapted to vary fiber elongation with concomitant change in diameter using a mechanical tensioning device or a sheathing fluid. They also prepared co-extruded fibers using another adaptation of this technique.

The researchers said that this new fabrication method will find increasing use to prepare ceramic and highly loaded ceramic/polymer nanocomposite fibers from a variety of material combinations at low temperature and pressure with dimensions of 15–500 μm and controlled composition and microstructure.

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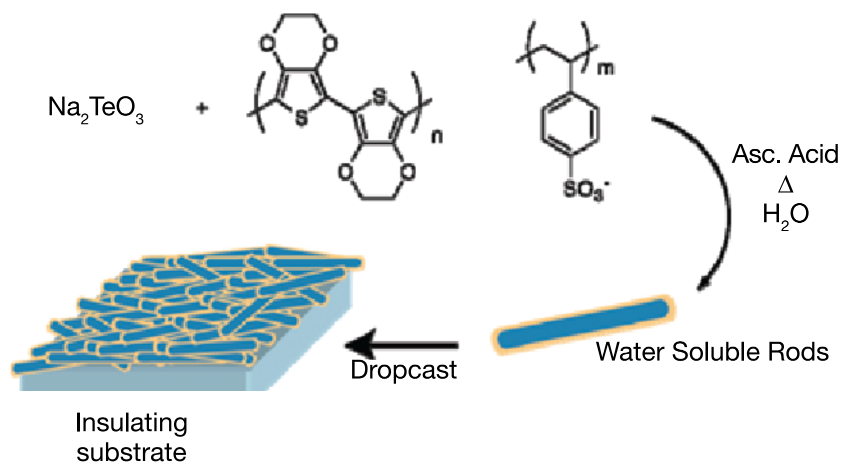
Nano Focus

High thermoelectric efficiency achieved in polymer-nanocomposites

Researchers R.A. Segalman (University of California, Berkeley and Lawrence Berkeley National Laboratories), J.J. Urban (Lawrence Berkeley National Laboratories), A. Majumdar (Advanced Research Projects Agency–Energy), and their co-workers have reported the highest thermoelectric figure of merit for an organic–inorganic hybrid or aqueously processed material to date. Thermoelectric efficiency is related to a combination of high thermopower (or Seebeck coefficient, S, V/K), high electrical conductivity (σ, S/cm), and low thermal conductivity (κ, W/m K). To date the best materials available have been inorganic compounds with relatively low earth abundance and highly complex processing routes (and hence greater expense), such as Bi_2Te_3.

In the last decade, polymers with much enhanced electrical conductivities (>100 S/cm) have become common, and work on molecular junctions indicate that the organic–inorganic interface can provide a boost to Seebeck coefficient. As reported in the October 5th online edition of *Nano Letters* (DOI: 10.1021/nl102880k), the researchers combine a high electrical conductivity, low thermal conductivity polymer with a nanoparticle that contributes high thermopower. Additionally, the work functions of the two materials could be well aligned which opens the possibility of thermionic filtering at the interface and an additional boost to the power factor. In this case, the nanoparticle is composed of tellurium with a very high thermopower (~400 μV/K), but relatively low electrical conductivity and high thermal conductivity. The research team has shown that Te nanorods can be synthesized *in situ* into a highly electrically conductive, thermally insulating polymer (PEDOT:PSS, σ >100 S/cm, κ ~ 0.2W/m² K) in a water solution (see figure).



(a) Synthesis of PEDOT:PSS passivated Te nanorods and (b) dropcast composite film on a 1 cm² quartz substrate, showing excellent film uniformity. Reproduced with permission from *Nano Letters* (2010) DOI: 10.1021/nl102880k. © 2010 American Chemical Society.

Suspended polymer coated rods can then be dropcast to form a smooth, conformal film. This film has an electrical conductivity two orders of magnitude higher than the Te nanowires and similar to a pure sample of the polymeric component at greater than 10 S/cm. The thermal conductivity for the hybrid is on the order of 0.2 W/(m K), comparable to the polymeric component. The Seebeck coefficient of the hybrid was 163 μV/K.

Thermoelectric efficiency is normally reported as a figure of merit ($ZT = S^2\sigma T/\kappa$). A combination of these factors yield ZT values of ~0.1, which is the largest reported value for an aqueous processed material and the largest reported in an organic or organic–inorganic hybrid to date. This value represents a four order of magnitude increase over the pure polymer or Te nanowires. According to the researchers, these materials could find an important role in spot cooling of microelectronics and scavenging of low grade waste heat.

Jean L.W. Njoroge

Correction

In *MRS Bulletin* **35** (11)(2010) pp. 909, 910, the photo captions should be "E-MRS 2010 Spring Meeting."