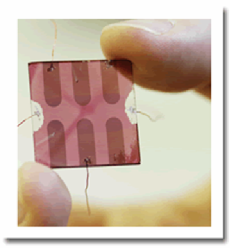
Australian Nanotechnology Alliance
Enabling Tomorrow

QUT

Solutions for Industry & the Environment
Case Study:
Organic Photovoltaics: An Alternative to Silicon Solar Cells

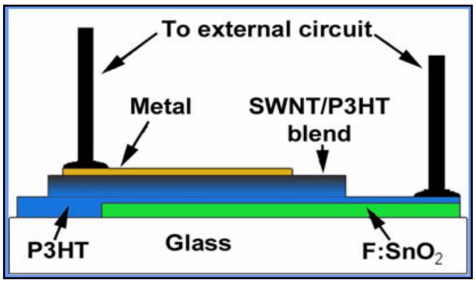
Researchers in the Applied Nanotechnology groups at QUT are developing low cost alternative photovoltaics, constructed from a thin film of a cheap composite material, a mixture of carbon nanotubes and conductive polymer.

The goal is power production with zero greenhouse gas emission by direct photovoltaic conversion of sunlight into electricity. Silicon solar cells are more commercially mature, but high production costs still limits their commercial viability.



Technical Background

The polymer poly-3-hexylthiophene (P3HT) forms the matrix of the heterojunction composite solar cells. P3HT has a high charge carrier mobility, and it has been shown that addition of fullerenes to P3HT increases photovoltaic efficiency (light to electrical energy conversion) substantially. 4.4% efficiency have been reached with this method. In this project, carbon nanotubes are added to P3HT, in order reach higher efficiency. An improvement is expected because of the higher conductivity of the nanotube fraction with respect to the fullerene. A typical device structure is shown here.



Research Questions

The efficiency of the charge separation process relies on the conductivity of the polymer (for holes) and carbon nanotubes (for electrons). The excellent charge-transport capability of carbon nanotubes is expected to enhance the conductivity of the mixture.

Preliminary results show poor light conversion efficiency compared to fullerene-doped systems. Limited polymer conduction due to disorder in the polymer, and a random structure of dispersed carbon nanotubes, leading to the absence of a percolation path are both believed to be responsible. We are investigating the morphology and ordering of the nanotube-polymer mixture and their influence on interfacial traps. A key focus is the mechanism of polymer wrapping of the nanotubes.

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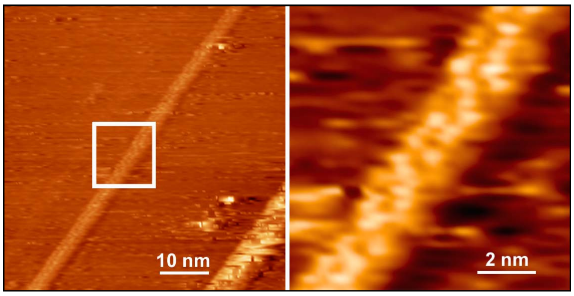
Scanning Tunnelling Microscopy investigations

Scanning Tunnelling Microscopy (STM) has revealed that the polymer wraps around isolated nanotubes in a regular fashion. The nanotube can act a template for the deposition of the polymer, resulting in a highly ordered form of the polymer, with high conductivity.

The key to highly efficient devices made this way is achieving a well ordered array of nanotubes, avoiding clustering.



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