Reversible Doping of Semiconductor Films for Electronics

A method for controlling the degree of doping of an organic semiconductor film

Georgia Tech researchers have developed a process to control the solubility and electrical conductivity of organic semiconductor films through reversible solution doping. Thin layers of organic semiconductor go through a multi-step liquid immersion process to be initially doped, then de-doped. This process allows for the organic semiconductor to increase conductivity without degrading the electrical properties of the material. A plurality of inorganic or organic semiconductor layers are immersed in a dopant solution and applied to a portion of the organic semiconductor. This produces a functional electro-optic device where the doped organic semiconductor layer facilitates transport or collection of charge carriers from the device. The dopants used are frameworks of transition metal oxides known as polyoxometalates, which are thermally and oxidatively stable, making it an ideal dopant that is easily controlled.

Summary Bullets

- **Effective –** Reduction in film's electrical resistance
- **Scalable –** Can control doping of large or small-scale bulk materials
- **Simplified –** Allows for stacking of organic semiconductor layers without cross-linking the layers

Solution Advantages

- **Effective –** Reduction in film's electrical resistance
- **Scalable –** Can control doping of large or small-scale bulk materials
- **Simplified –** Allows for stacking of organic semiconductor layers without cross-linking the layers
- **Improved Devices –** Controlled doping leads to a more stable electronic device

Potential Commercial Applications

- Organic Electronic Devices (Solar Cells, Light-Emitting Diodes, etc.)
- Organic Sensors
- Printed Electronic Devices

Background and More Information

Doping semiconductor materials enhance the conductivity of the material, but this process is not easily controlled. Chemical doping is typically done by mixing dopant (strong electron donor or acceptor atoms or molecules) within a bulk material. While this process typically increases conductivity, sometimes it may result in degradation the electrical properties of the material or film due to lack of control in the degree of doping. Other chemical doping methods have similar issues, which hinder the ability to use doped semiconductors for electronic applications. Controlling the degree of doping in semiconductors has been a challenge in current industrial processes for electronics.

Inventors

- Dr. Bernard Kippelen
  Professor - Georgia Tech School of Electrical and Computer Engineering ; Director, Center for Organic Photonics and Electronics
- Dr. Seth Marder
  Regents Professor - Georgia Tech School of Chemistry and School of Materials Science and Engineering
- Naoya Aizawa
  Visiting Associate Professor - Kyushu University
- Junji Kido
  Professor - Yamagata University Department of Organic Device Engineering
- Canek Fuentes-Hernandez
  Research Scientist II — Georgia Tech School of Electrical and Computer Engineering

IP Status

Patent has issued<o:p></o:p> : US10763447B2

Publications

, -

Images

Visit the Technology here:
Reversible Doping of Semiconductor Films for Electronics