PENN CENTER FOR INNOVATION
Empowering Ideas

Polymer nanocomposite films with extremely high nanoparticle loading

Material synthesis through capillary rise infiltration

Inventor

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STAGE OF DEVELOPMENT

Proof-of-principle testing

INTELLECTUAL PROPERTY

PCT pending
(WO 2015175543 A1)

REFERENCE MEDIA

Huang et al. Nanoscale, 2015, 7, p. 798-805.

APPLICATIONS

- Generation of high filler fraction PNCFs with different sets of polymers and nanoparticles
- Dye-sensitized solar cells
- Batteries
- Separations/membranes
- Coatings
- Display devices

DESIRED PARTNERSHIPS

License
Co-development

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Docket # 14-7115

Problem

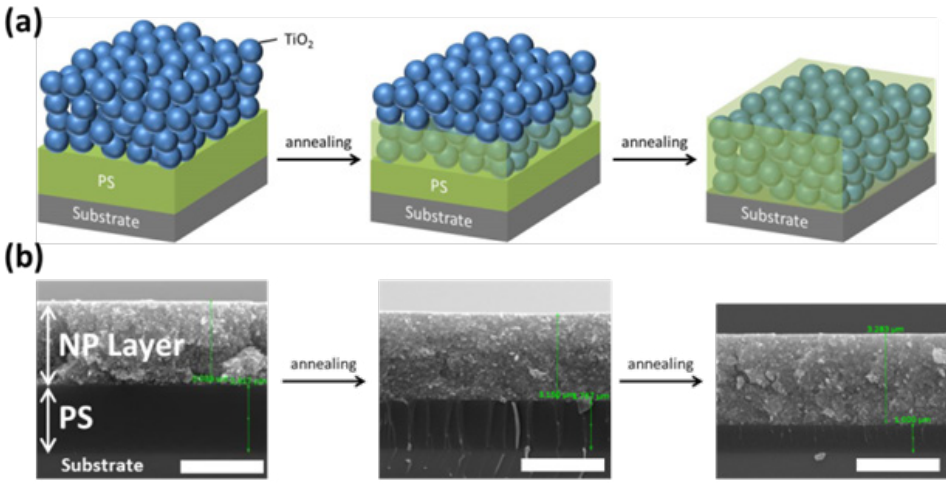
Polymer nanocomposite films (PNCFs) combine the electronic, mechanical, and optical properties of nanoparticles with the flexibility of polymers to yield nanostructured films. PNCFs with extremely high nanoparticle concentrations are important components in energy storage and conversion devices, as well as in protective coatings. However, these PNCFs are difficult to prepare because of the poor processability of polymer-nanoparticle mixtures with high concentrations of nanoparticles; this problem is exacerbated with anisotropic nanoparticles.

Solution

Using a technique based on capillary rise infiltration (CaRI) of polymer into a dense packing of nanoparticles, the Lee lab is able to obtain high packing densities. A two-layer film, comprised of a polymer layer and a nanoparticle layer, is generated and annealed at a temperature that imparts mobility to the polymer. The polymer infiltrates the interstices of the nanoparticle layer. This approach has been demonstrated with monodisperse polystyrene and titanium dioxide nanoparticles. Compared to films made from individual components, PNCFs generated from CaRI have superior mechanical properties, including hardness, modulus, scratch/wear resistance, and the ability to heal nanoparticle films with cracks that exist prior to annealing.

Advantages

- Straightforward, scalable process to generate PNCFs
- Uniform nanoparticle distribution
- Extremely high filler concentrations
- Synthesized material has superior mechanical properties



Infiltration of polystyrene into TiO2 nanoparticle film due to capillary action.