The PNNL-developed two-step, wet deposition coating process selectively blocks and redirects ultraviolet, visible, and infrared light making it highly tailorable for a variety of industries and applications, such as windows for buildings, aerospace, and land vehicles; roofing; paints; coatings on LEDs; food packaging; and more. Variety and lower cost.

Subwavelength Optical Coatings

Battelle Number(s): 30638-E

Clearance Number:

Patent(s) Issued:

Available for licensing in all fields

SUMMARY

Industry seeks advanced optical coatings to selectively block and redirect light. Such coatings enable energy-efficient window films or coatings for buildings, aerospace and vehicles, building envelope materials, display coatings, and tamper-resistant seals. By one estimate, if optical coatings could dynamically and selectively control both visible and infrared light for windows, building owners could save up to 20% in cooling costs and up to 30% in annual heating costs. Some window technologies can dynamically switch between blocking and transmitting light, but these technologies are not well established in the market, are prohibitively expensive to produce, and block both visible and infrared heating, masking the view out the window and preventing natural lighting.

PNNL's subwavelength coatings could meet these needs. With additional development, the process is scalable to very large sizes (meters squared) appropriate for buildings and windows in a high-throughput roll-to-roll fashion and can be manufactured at low cost. These coatings have the potential to control ultraviolet, visible, and infrared light.

The PNNL subwavelength coatings or films are layered with dimensions less than the wavelength of electromagnetic radiation (light) reflected, transmitted, absorbed, or redirected by the coating. This approach means that, to redirect ultraviolet, visible, or near-infrared light, the layers are nanoscale in dimension. For larger, thermal wavelengths, micron-sized structures are needed. Whether composed of nanostructures or microstructures, these coatings are deposited via roll-to-roll in two steps on a rigid or flexible substrate through wet deposition. The first layer comprises dielectric spheres of subwavelength dimension that self-assemble on the substrate to form a mono- or single-layer close-packed scaffold of spheres with voids in between. The second deposition step fills these subwavelength voids with much smaller nanoparticles of a different material. Both layers are then heated at a preselected temperature to sinter the smaller nanoparticles to form the durable spectrally selective coating that can redirect ultraviolet, visible, and infrared light, depending on the size of the nanoparticles. Thus, the approach is highly tailorable.

Applications

These coating could be used in many applications, such as:

http://availabletechnologies.pnnl.gov/technology.asp?id=446
Windows for homes, aerospace and land vehicles, and commercial buildings to manage thermal heating, visible light, and ultraviolet light

- Roofing and building envelope materials for thermal management and radiative cooling
- Vehicle, building, and aerospace paint for thermal control
- Enhancement of solar cells and scintillators
- Directional emission photonic coatings for high-brightness LEDs
- Food packaging for maintenance and tamper-evident sealing
- Biofouling prevention for turbines and marine vessels
- Specialty display coatings for electronics.

ADVANTAGES

- Could dramatically lower costs over current techniques; for example, the approach is expected to cost less than 10% of that for electrochromic technologies
- Is the only technology scalable to large areas needed for most industrial applications
- Adapts current industrial processes for rapid and high-volume manufacturing at large scale, rather than requiring completely untested techniques
- Compatible with retrofitting efforts

RELATED LINKS

- "Optically resonant subwavelength films for tamper-indicating tags and seals."

- "Subwavelength films for standoff radiation dosimetry."

PATENTS & INTELLECTUAL PROPERTY

- 9,580,793

TECHNOLOGY PORTFOLIO(S)

- Energy Conversion & Efficiency
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