Electromagnetic Wave Broadband Angular Selectivity

Technology #16896

Applications

An angularly dependent material-system can be used in solar energy conversion, privacy protection, and high signal-to-noise detectors.

Problem Addressed

In currently known angularly selective systems, the transmission of light depends on the light frequency. This material-system decouples the frequency and the viewing angle, so that there is transparency throughout the visible spectrum at one angle and reflection at every other angle.

Technology

The material-system is achieved through two separate approaches. Both operate under the following principles: all dielectrics have a Brewster Angle, angle of incidence at which light is completely transmitted, and the location of the bandgap scales proportionally to the periodicity of the quarter-wave stack (i.e. the bandgap can be controlled by stacking layers of quarter-wavelength thickness). Therefore, the effective bandgap can be enlarged by stacking quarter-wave stacks with various periodicities together and if all of these layers have the same Brewster Angle then the entire stack will theoretically transmit all frequencies of light incident at a particular angle. The first approach is photonic crystals that consist of only isotropic materials. This approach consists of 84 layers of Silicon dioxide (SiO2) and Tantalum pentoxide (Ta2O5) fabricated with Bias Target Deposition (BTD) technique and fused on a silica wafer. The sample is transparent to p-polarized incident light at the angular window of transparency (55o±8o), and behaves like a mirror at all other incident angles over the entire visible spectrum. For s-polarized, light the sample behaves like a mirror at all angles, but this can be overcome with a mirror and polarization "flipper". In the first approach, the Brewster angle is limited to angles >45o and is not very tunable. This is overcome in the second approach which consists of isotropic and anisotropic layers, which can be made out of polymers (PET and PMMA) or metamaterials (Rogers R3010 panel and polypropylene). The second approach used only 12 periods of layers to demonstrate the concept. This angularly selective system can change the form of waves from a point source to plane waves and increase the resolution of systems like GPS and Radar that currently rely on interactive wave propogation. This method can also be implemented for systems that have Brewster angle analogs, such as acoustic and elastic waves.

Advantages

- Ability to transmit light independent of frequency for one incident angle
- Tunable transmission angle

Categories For This Invention:

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Energy
Solar
Materials
Micro & Nanotech
Thin Films
Photonics
Sensors (Photonics)
Detectors

Intellectual Property:

Methods and apparatus for broadband angular selectivity of electromagnetic waves
Issued US Patent

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Publications:

Broadband Angular Selectivity of Light at the Nanoscale: Progress, Applications, and Outlook
Applied Physics Review
2016
Metamaterial Broadband Angular Selectivity
Physical Review B
September 15, 2014
Optical Broadband Angular Selectivity
Science
March 28, 2014

External Links:

Photonics and Modern Electro-Magnetics Group
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Nanostructures and Computation Group
http://math.mit.edu/~stevenj/group.html

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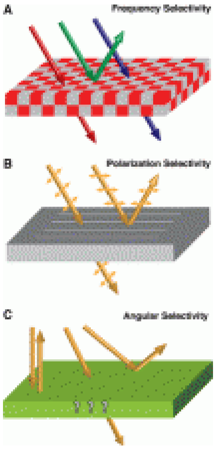

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