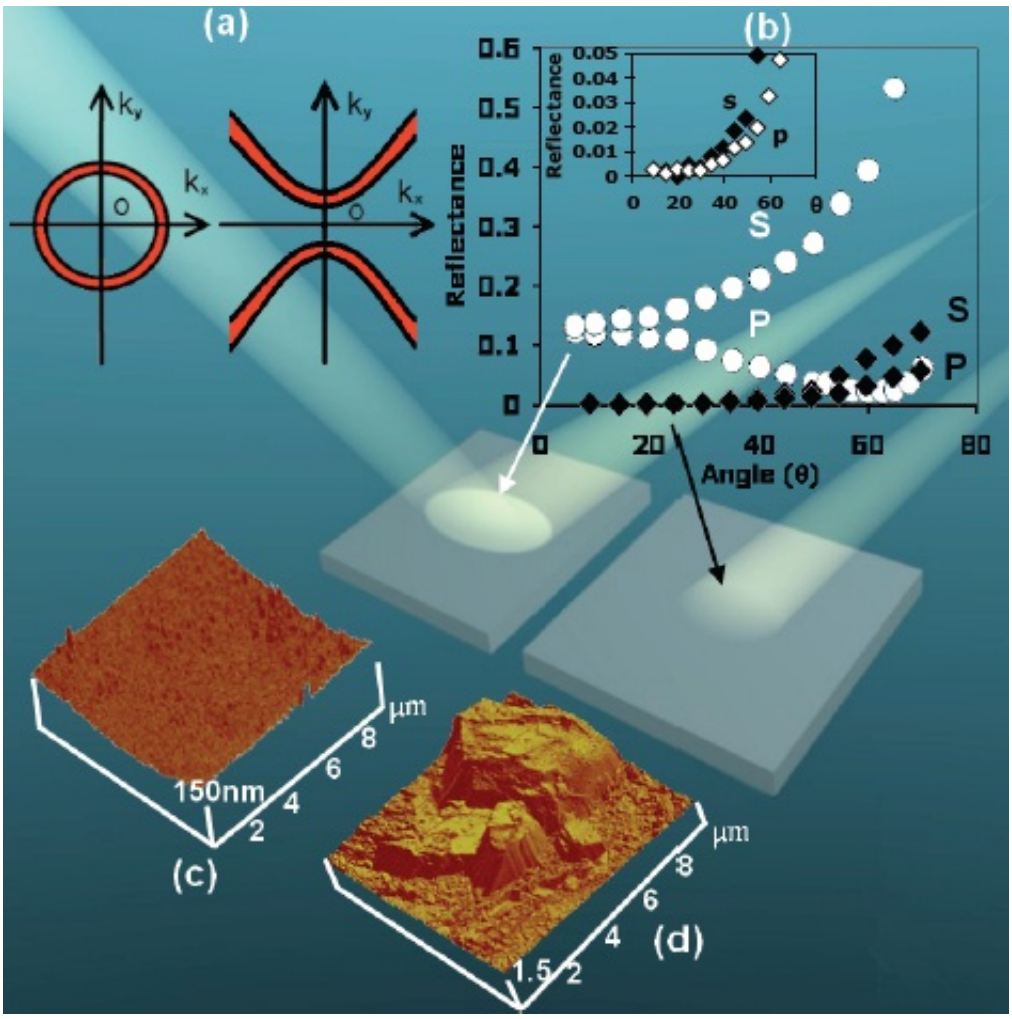
'Darker-than-black' metamaterial could lead to more efficient solar cells

September 30 2011, by Lisa Zyga



When a hyperbolic metamaterial is corrugated, its reflectance is greatly reduced and it becomes "darker than black." Image credit: E. E. Narimanov, et al.

(PhysOrg.com) -- If typical black paint absorbs about 85% of incoming light, then a newly designed metamaterial that absorbs up to 99% of incoming light may be considered “darker than black." By taking advantage of the unique light-scattering properties of metamaterials, researchers have discovered that a hyperbolic metamaterial with a corrugated surface can have a very low reflectance, which could make it promising for high-efficiency solar cells, photodetectors, and radar stealth technology.

The researchers, E. Narimanov, et al., from Purdue University and Norfolk State University, have posted their study on the radiation-absorbing metamaterial at arXiv.org.

In their study, the researchers fabricated a hyperbolic metamaterial out of arrays of silver nanowires grown in alumina membranes. They found that this material absorbed about 80% of incoming light. Then, they ground the surface of the metamaterial to produce corrugations and defects, which they predicted would dramatically reduce the light reflection, increasing the absorption. Their measurements showed that the corrugated metamaterial absorbed up to 99% of incoming light, and that the radiation-absorbing capability is applicable to all parts of the electromagnetic spectrum.

As the scientists explained, the metamaterial’s very low reflectivity results from one of its hyperbolic properties: an infinite density of photonic states. This “super singularity” greatly increases the amount of light scattering from surface defects and corrugations in the metamaterial. The defects and corrugations scatter light primarily inside the material, basically “sucking” photons inside the hyperbolic medium.

The researchers predict that the new metamaterial will provide a new route toward designing radiation-absorbing materials. As light absorption plays a key role in solar cells and many other applications, the

researchers plan to investigate these possibilities in the near future.

More information: E. E. Narimanov, et al. "Darker than black: radiation-absorbing metamaterial." arXiv:1109.5469v1 [physics.optics]

via: Physics arXiv Blog