COLLEGE OF ENGINEERING
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Research Horizons Day
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Solar Light Perfect Absorbers Using Cascade Cavity Metal-dielectric Layer Structures

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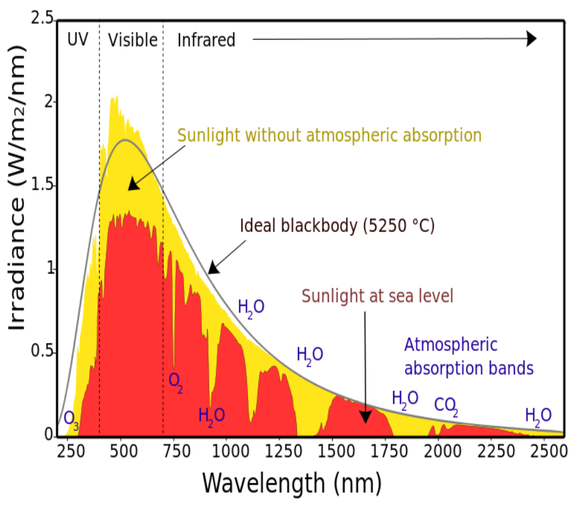
Overview

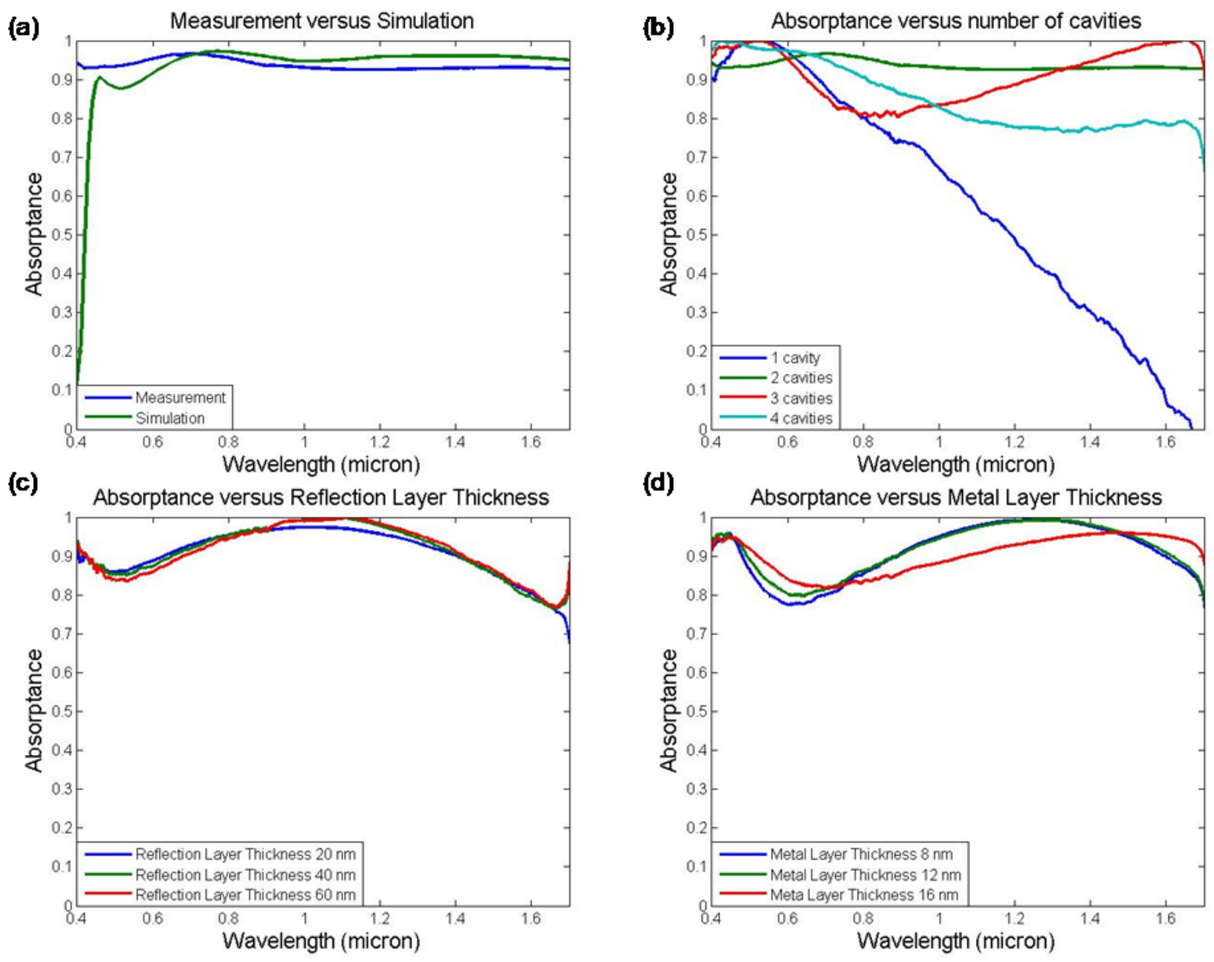
Super wide-band perfect solar light absorbers were designed and fabricated based on unpatterned metal-dielectric thin film layer structures. The devices can efficiently absorb solar light within a wide spectrum of the solar radiations. Calculations were carried out to simulate the absorption in the structures by using the transfer matrix approach for different metal-dielectric layer thicknesses. Fabricated devices were measured and the measurement results show that the cascade metal-dielectric nano-cavity absorbers have near perfect light absorption over a wide spectral range from 400 nm to 2500 nm.

Spectrum of Solar Radiation (Earth)



Anti-Reflection Layer	**SiO_2**
Metal layer 1	**Ti**
Dielectric layer 1	**SiO_2**
Metal layer 2	**Ti**
Dielectric layer 2	**SiO_2**
Reflection Layer	**Al**
Substrate	**Silicon wafer**

`Experimental Results



Conclusions

- Demonstrate wide-band absorbers with near unit absorption from 400 nm to 2500 nm solar spectral range.
- The wide-band solar light perfect absorbers are polarization independent and are intrinsically low cost.
- The devices can absorb wide-band solar light at large angles of incidence.

Acknowledgements

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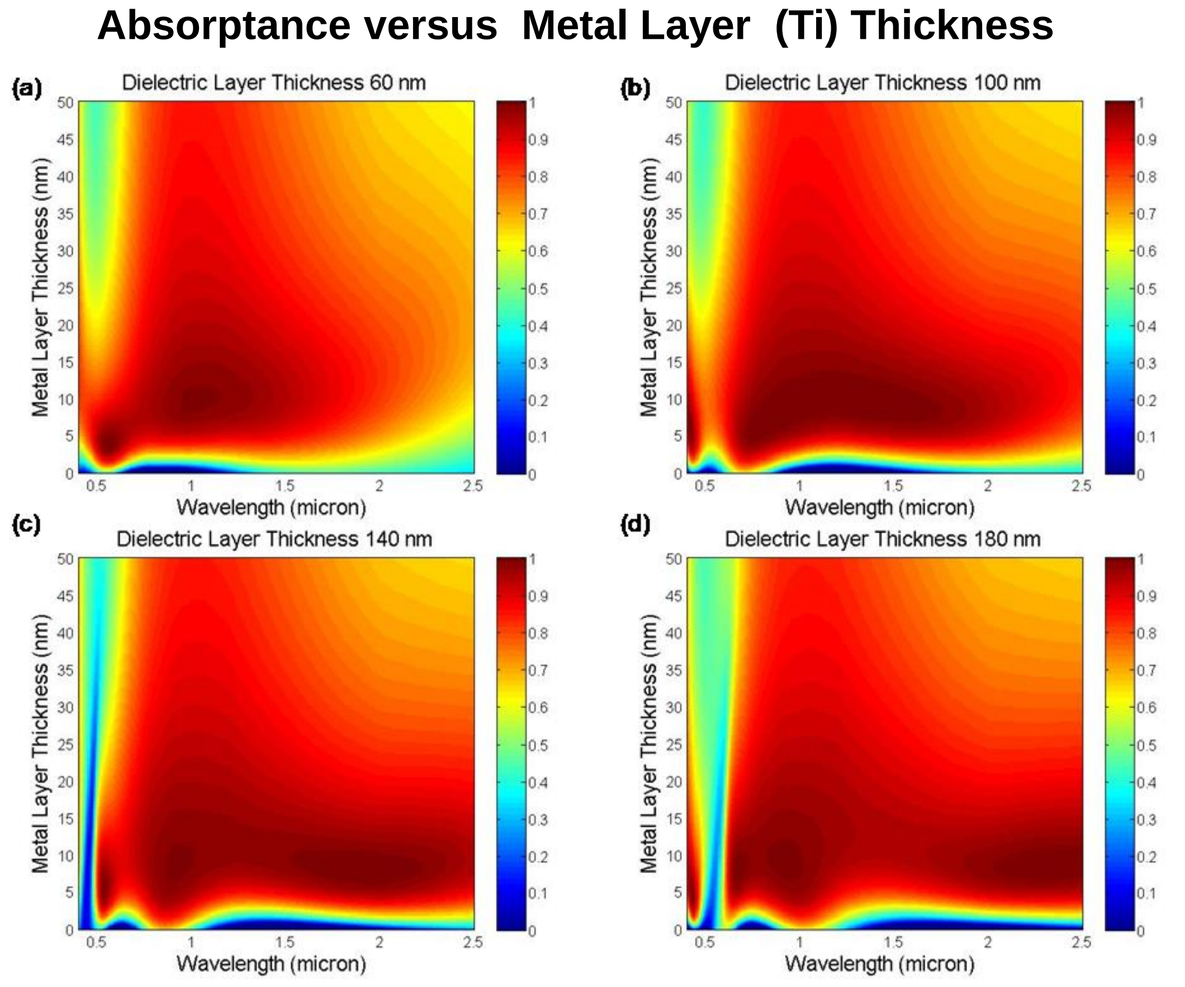
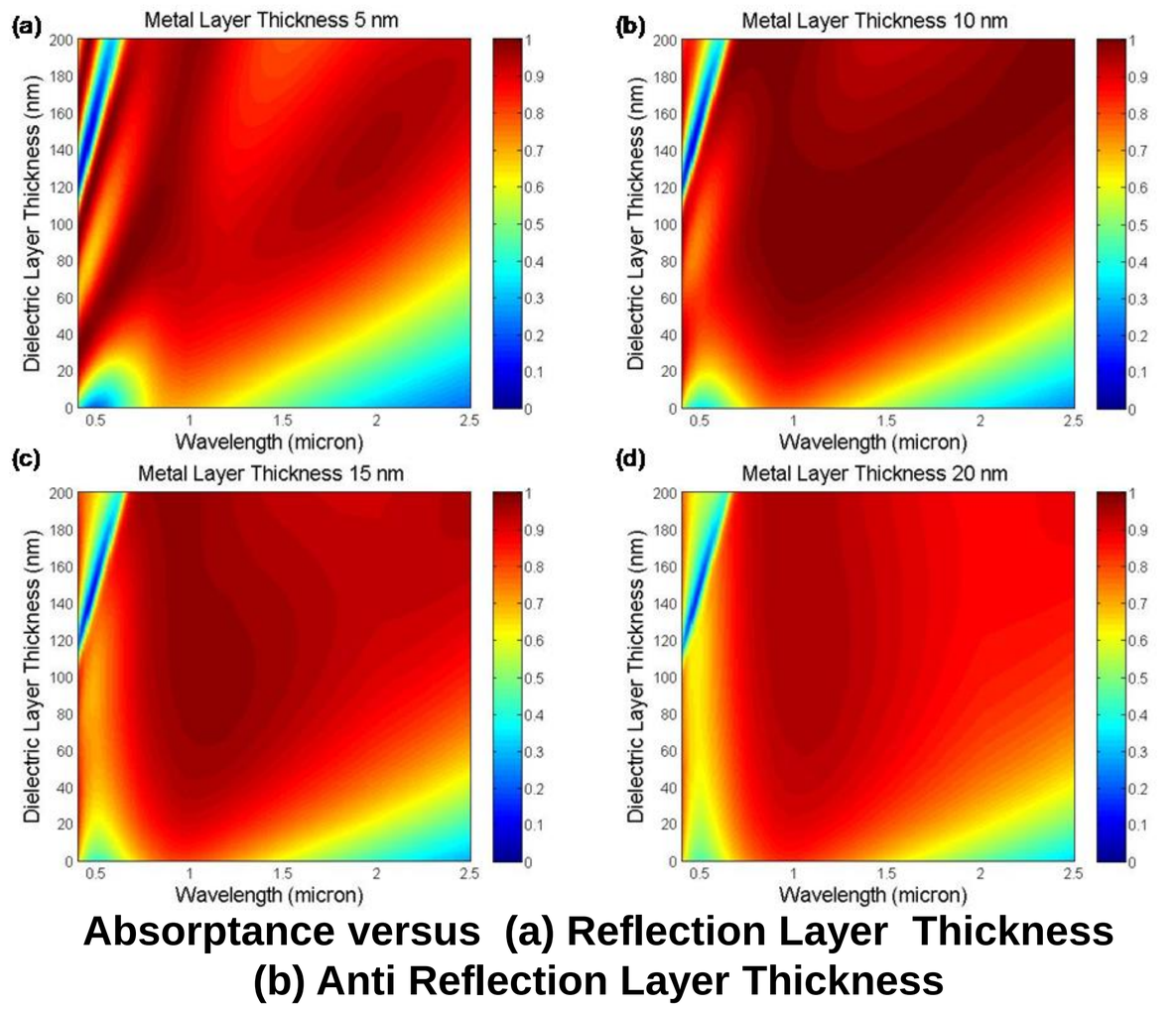
Transfer Matrix Calculations of Absorption

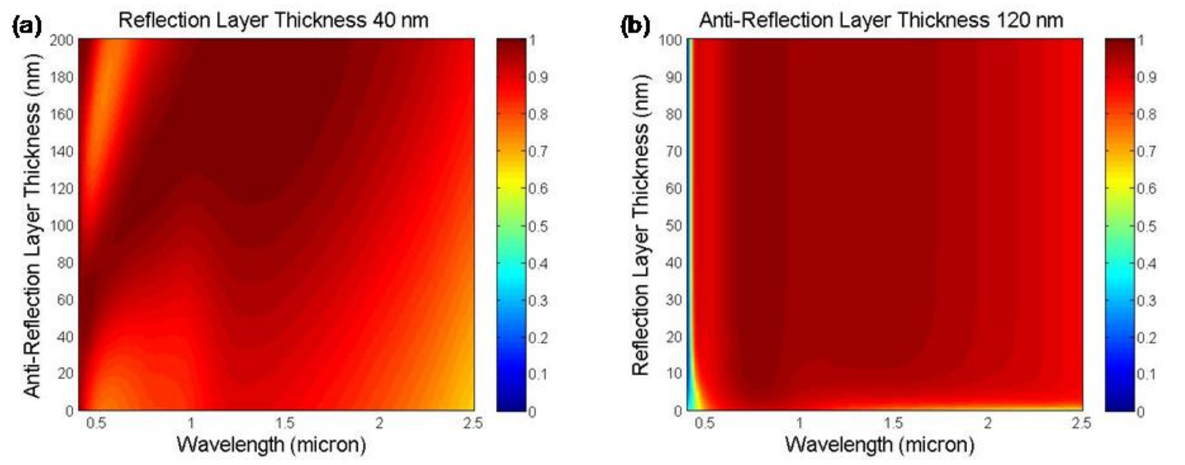
Absorptance versus Metal Layer (Ti) Thickness



Absorptance versus Dielectric Layer (SiO_2) Thickness



Absorptance versus (a) Reflection Layer Thickness (b) Anti Reflection Layer Thickness



Transfer Matrix Theory

$$\begin{bmatrix} M_{11} & M_{12} \\ M_{21} & M_{22} \end{bmatrix} = D_{air}^{-1} * \left[D_0 P_0 D_0^{-1} \right] * \left[D_m P_m D_m^{-1} D_s P_s D_s^{-1} \right]^N * \left[D_a P_a D_a^{-1} \right] * D_{sub}$$

$$\mathrm{R} = \left| r^2 \right| = \left| M_{21} / M_{11} \right|^2 \quad T = \left| \frac{n_s \cos(\theta_s)}{n_{sub} \cos(\theta_{sub})} \right| * \left| \frac{1}{M_{11}} \right|^2$$

CAO The Center for Applied Optics