COMSOL CONFERENCE 2015 PUNE

Plasmonic Scattering Structures for Improved Performance of Thin Film Solar Cells.

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Great: Develop Great Technology.

Growth:Grow into a Billion Dollar Company by 2020.

Our Solution

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Engineering Apps for Design on the Go

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Introduction & objectives

- Solar is a promising renewable energy Technology.
- Thin film photovoltaics is a promising technology for the growth of solar industry.
- This paper explores the potential for increasing the solar absorbance and broadband response of thin film solar cells by multi-level plasmonic scattering elements.

Plasmonic solar cells

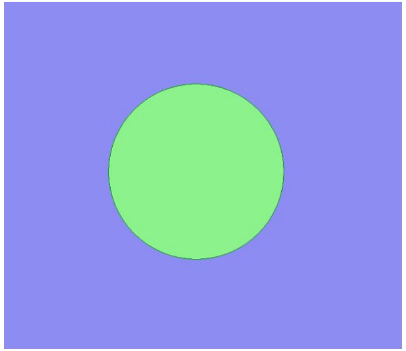
- Plasmonic solar cells are photovoltaic devices that convert light into electricity with the usage of plasmons

- Around 40% of the cost of a solar module made from crystalline silicon is the cost of the silicon wafers. So plasmonic solar cells can be replaced by crystalline silicon in order to cut the cost.

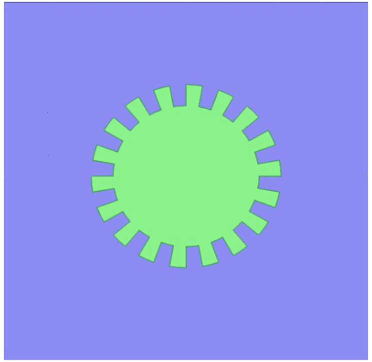
- Higher Absorption and broadband response is a challenge.

Structuring plasmonic cells

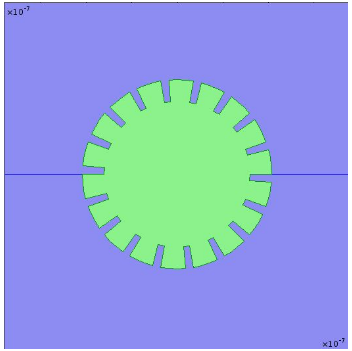
A circular and multi level corrugated circular shaped features plasmonic structural configuration is considered and the effectiveness of these structures for enhancing the absorbance and broadband response is investigated.



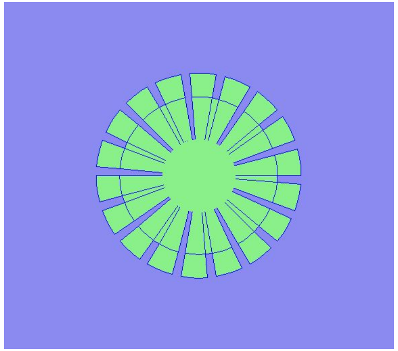
case psa



case psb



case psc



case psd

Computational methods

Nano plasmonic scattering structures embedded in a dielectric medium is modelled as electromagnetic wave propagation in the frequency domain with periodic boundary conditions using AC/DC module.

Time-harmonic wave equations in the electric field *E* and the magnetic field *H*:

$$\nabla \times \nabla \times \vec{E} - n^2 k_0^2 \vec{E} = 0$$

$$\nabla \times \left(\frac{1}{n^2} \nabla \times \vec{H}\right) - k_0^2 \vec{H} = 0$$

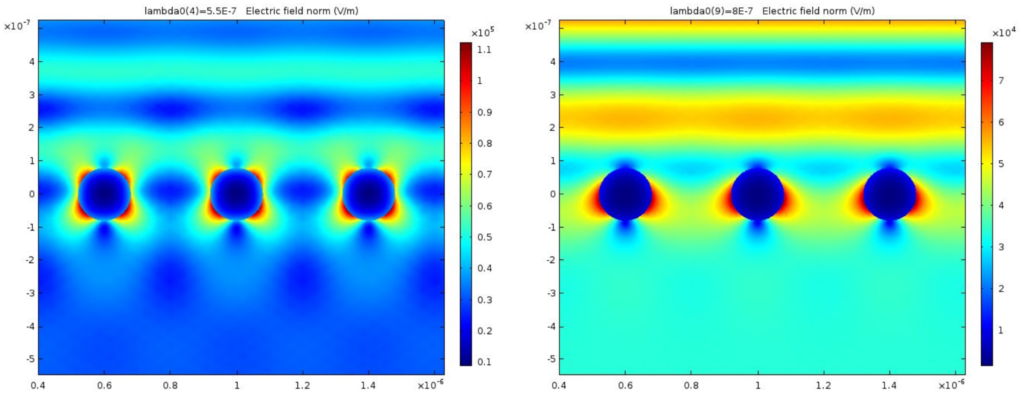
Where, n , complex refractive index
k_0 , magnitude of the free-space wave

Simulation Results

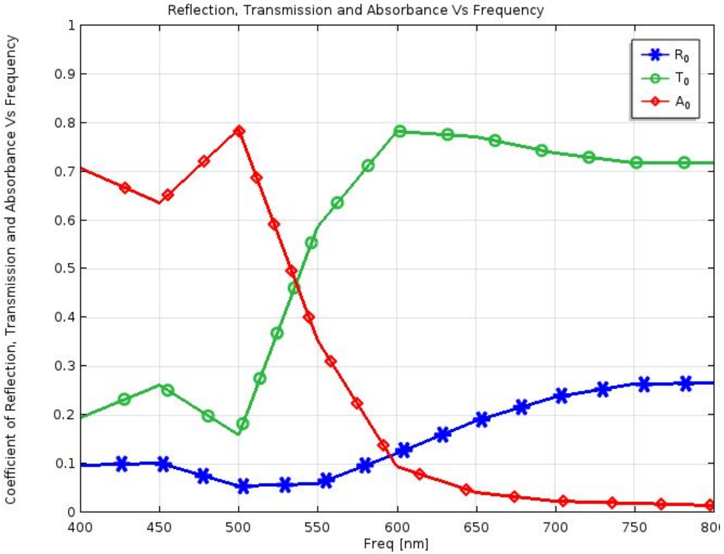
- Investigated wave propagation and interaction in the visible spectrum band
- Absorbance,Reflection and Transmission Vs Frequency
- Focus on broadband increase in absorbance
- Average absorbance is calculated and compared for various cases.

CASE psa

- Contour plots of electrical field normals at 550nm, 800nm



- Coefficient of reflection, transmission and absorbance with respect to frequency

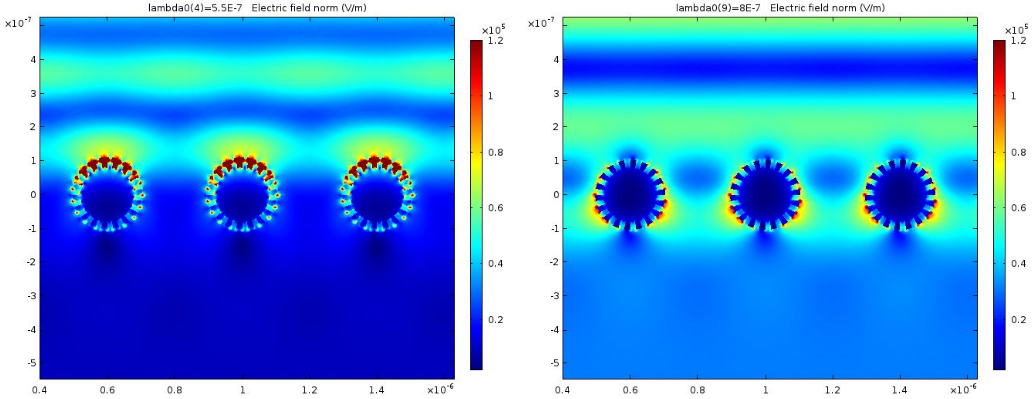


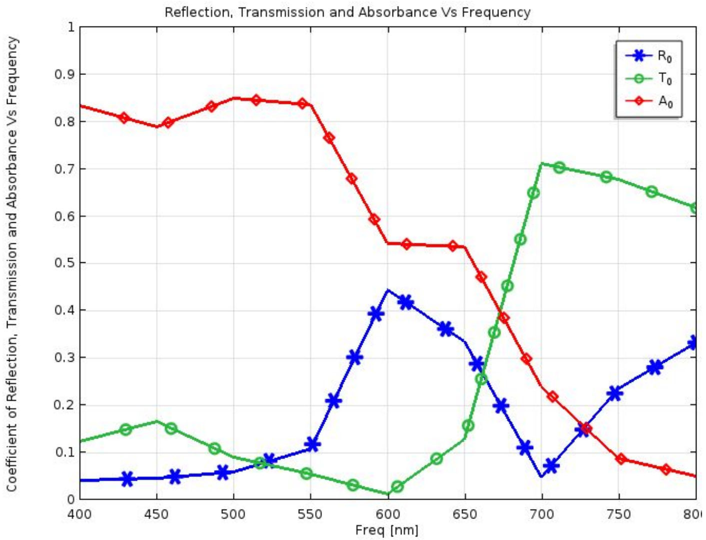
- Absorbance coefficient ~0.30

CASE psb

- Absorbance coefficient ~0.53

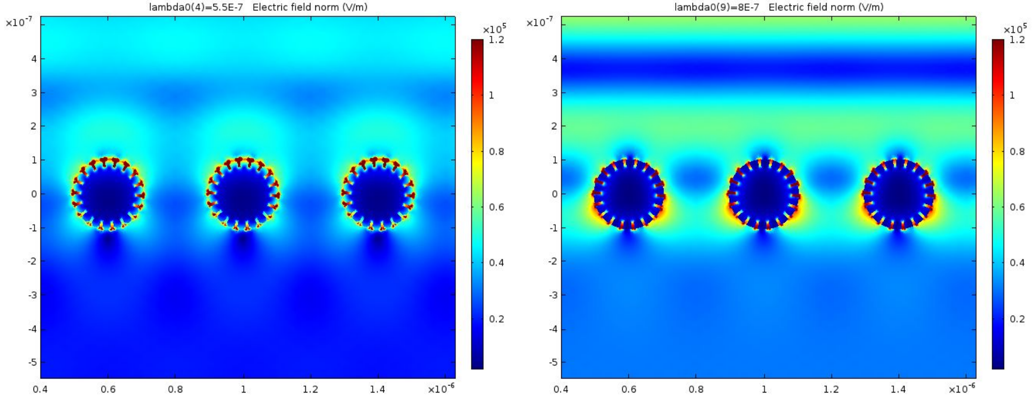
- Case psb is 78% better than case psa in absorbance

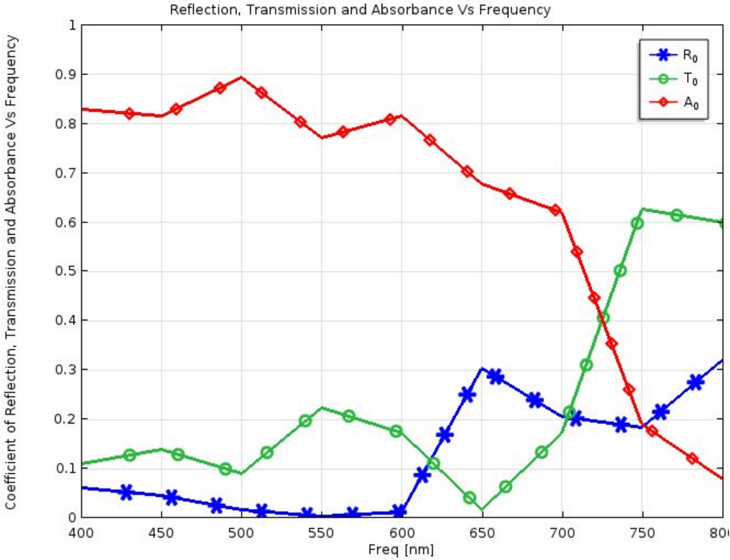




CASE psc

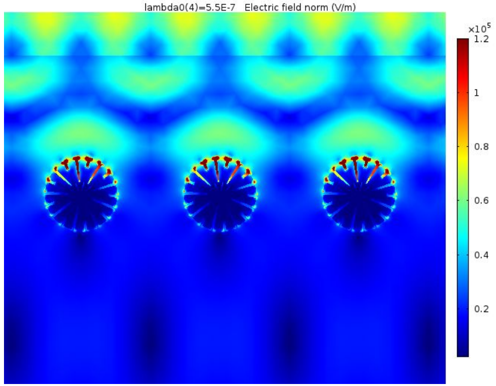
- Absorbance coefficient ~0.63
- Case psc is 112% better than case psa in absorbance

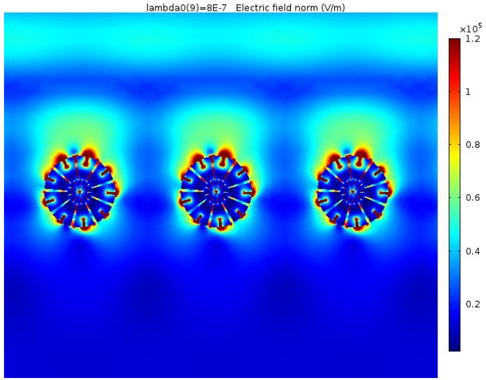


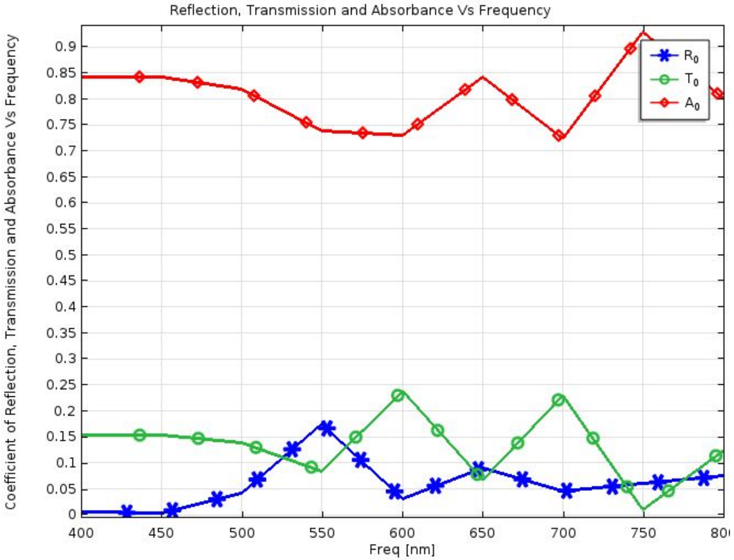


CASE psd

- Absorbance coefficient ~0.81
- Case psd is 172% better than case psa in absorbance
- Broadband response

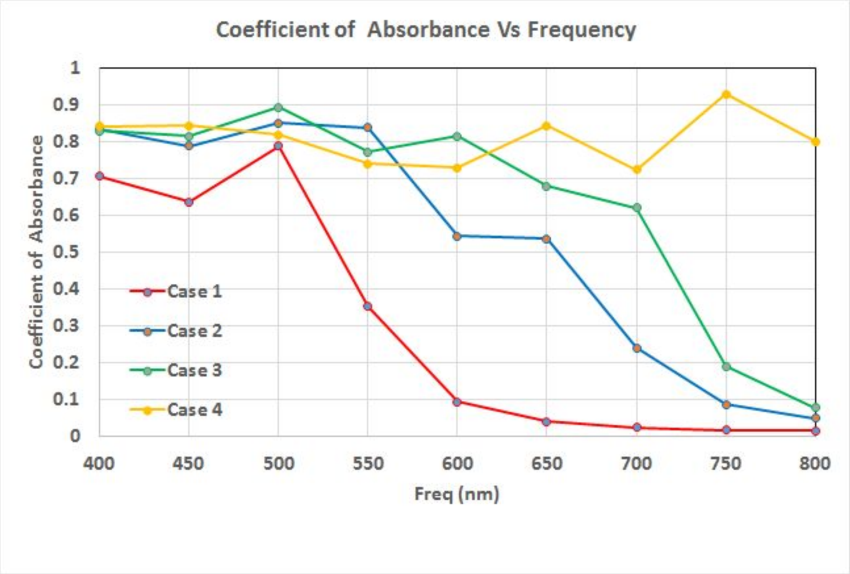






Summary of results

The results show the increase in absorbance coefficient of corrugated circular structures and improved broadband response of visible spectrum.



plasmonic structures	case psa	case psb	case psc	case psd
Absorbance Coefficient	0.30	0.53	0.63	0.83

Conclusion & Future work

- Computational electromagnetic investigation demonstrated the potential for increasing the solar absorbance and broadband response of thin film solar cells by multi-level plasmonic scattering elements.

- Highly efficient plasmonic structures can fuel the solar Photovoltaics industry growth and proliferation of low-cost thin film solar cells.
- Future: Fabrication technologies and extension of absorbance into IR spectrum

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