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

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## Abstract

Solar Photovoltaics is an alternate green energy source to the depleting fossil fuel technologies. Solar energy cost needs to be reduced significantly for competitiveness and proliferation in residential solar. Thin film photovoltaics is a promising technology for the growth of solar industry.

In this paper, nano scale plasmonic structures are explored for performance improvement. These structures provide novel ways to guide concentrate and trap light within thin film solar cells for enhancing absorbance and the overall performance. Plasmonic structures for sub wavelength scattering, nano scale antenna and corrugated guides are under development. In this paper, novel multilevel scattering element is investigated to increase the solar absorbance. Nano plasmonic scattering structures embedded in a dielectric medium is modelled leveraging COMSOL Multiphysics® 2D Electromagnetic wave propagation in the frequency domain with periodic boundary conditions. The performance of the plasmonic structures depends on the polarization of the incident wave, hence, both transverse electric and transverse magnetic simulations are considered. The model is set to sweep across the incident wave frequency range from 400 nm to 800 nm and to measure reflection, transmissions and absorption coefficients.

A circular and corrugated circular shaped plasmonic structural configuration is considered as shown in Figure 1a and Figure 1b, respectively. The effectiveness of these structures for enhancing the absorbance and broad band response is investigated. Figure 2 shows the results contour plots of electrical field normal for both the shapes. Figure 3 shows, reflection, transmission and absorption coefficient of circular (Figure 3a) and corrugated circular (Figure 3b) structures, respectively. The results show the increase in absorbance coefficient of corrugated circular structures. The frequency sweep results also highlight the improved broadband response of the corrugated circular structures.

This 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. Further investigation on the effect of diameter, shape of corrugated structure, layered systems and extended frequency range including IR spectrum will be reported. This study can fuel the solar Photovoltaics industry growth and proliferation of low-cost thin film solar cells.

## Reference

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Atwater, H A, and Polman, A, Plasmonics for improved photovoltaic devices, Nature materials, VOL 9, MARCH 2010.
2.Catchpole, K.R and Polman, A, "Plasmonic solar cells," Opt. Express 16, 21793-21800 (2008).

## Figures used in the abstract

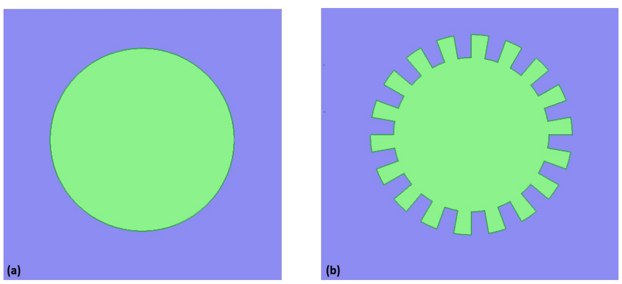


**Figure 1**: Circular (a) and Corrugated Circular (b) Plasmonic Structures.

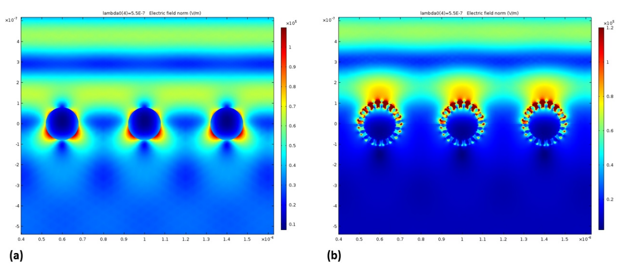


**Figure 2**: Electrical Field Normal Contour Plot of Plasmonic Structures.

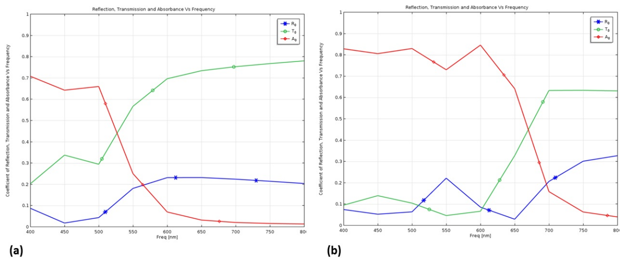


**Figure 3**: Reflection, Transmission and Absorption Coefficient Results.