

corresponds to a lattice spacing of 300 nm, which is in good agreement with the predicted performance shown in Fig. 3(d) based on calculated absorption enhancement. The increased enhancement observed for GA spirals follows from their circular Fourier space inducing the large-angle scattering effect discussed and modeled in Fig. 2.

Finally, we remark that that observed 31% integrated enhancement measured for GA spiral arrays has been demonstrated with only 25% of the active photodetector device area covered by GA arrays (Fig. 5d). This highlights the potential for even greater enhancement in the limit of complete device area coverage using GA spirals. While this study has focused on enhancing thin-film Si Schottky photodetectors, the unique plasmonic-photonic behavior of GA spiral arrays presented here are generally scalable to other solar cell material platforms and wavelength regimes. Moreover, a large class of deterministic aperiodic spiral arrays with divergence angles different from the golden angle remains to be explored, promising even more flexibility in Fourier space while maintaining almost ideal circular symmetry in multiple scattering rings [26].

6. Conclusion

We have experimentally investigated ultra-thin (100 nm) SOI Schottky photo-detector cells coupled to GA spiral and periodic Au nanoparticle arrays for efficient light trapping. We demonstrate that photodetector devices coupled to optimized GA spiral geometry enhance the spectrally integrated photocurrent by 31%, as compared to only 8% observed in periodic arrays. The resulting enhancement has been related to the distinctive properties of GA spirals, which give rise to strong photonic high-angle scattering behavior increasing the coupling into the thin-film absorbing Si layer and the localized plasmonic resonances atop the absorbing region, at significantly reduced metallic particles densities compared to periodic array. Our results are supported by electromagnetic modeling of angular radiation diagrams and absorption enhancement spectra based on CDA and FDTD numerical simulations. This study introduces a new engineerable platform providing broadband large-angle scattering and light trapping for applications in thin-film solar cells and for photodetectors enhancement.

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