

Metasurfaces enabling new solar cell designs

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For the successful large-scale deployment of solar energy conversion technologies—whether for generating electrical power or facilitating chemical processes—achieving effective broadband control of light-scattering is essential.[1] Managing how light interacts with materials is crucial for enhancing the efficiency and functionality of solar devices. One powerful approach to achieving this control is through the design of metasurfaces, which are engineered materials with tailored optical properties.

Light can be directed and distributed with remarkable precision by precisely structuring the spatial frequencies within these metasurfaces. This control over power spectral density allows light to be guided in specific directions, optimizing energy capture, reflection, or transmission according to the desired outcome.[2] Such flexibility opens new possibilities for improving the performance of solar energy systems. By mastering the angular control of light-scattering through metasurface engineering, we can unlock new potential in solar energy systems, paving the way for more effective, adaptable, and visually appealing renewable energy solutions.

In this talk, we will look at how to exploit power spectral density control with metasurfaces for several uses in solar cell devices. Broad-band scattering with optimized matching to waveguide modes maximizes light absorption in thin slabs, enabling the development of ultrathin and lightweight solar cells.[3,4] Color-selective isotropic back-scattering can provide colorful appearances so that solar cells can be implemented in urban spaces.[5] Distinctive angular scattering for different colors is also a long-sought component to improve tandem solar cells, either vertically or horizontally stacked.

REFERENCES

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