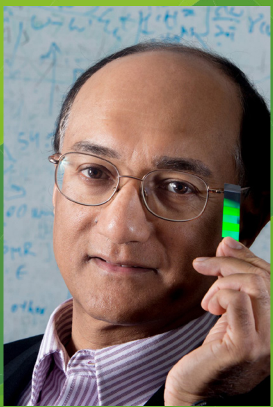
Physics & beyond

MPI Colloquium

06 September 2023 / 10:30 / Lecture Hall B.1.11



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Photonic Crystal Light Trapping for Next Generation Solar Energy Harvesting

The thermodynamic power conversion efficiency limit for silicon solar cells is 32.3%, while commercially available cells have efficiencies in the 17-22% range. The world record for silicon solar cells has inched upward from 25% to 26.8%, in the past twenty-five years, using cell thicknesses ranging from 450 microns down to 130 microns. Photonic crystal architectures enable broadband light absorption beyond the longstanding "Lambertian limit" and allow silicon to absorb sunlight nearly as well as a direct-bandgap semiconductor. When combined with state-of-the-art electronics, a technological paradigm shift appears imminent. I describe how wave-interference-based solar light-trapping in manufacturable photonic crystals can break longstanding barriers, enabling flexible, thin-film (15 micron), silicon to achieve an unprecedented, single-junction, power conversion efficiency over 30%.

1. "Beyond 30% Conversion Efficiency in Silicon Solar Cells: A Numerical Demonstration" S. Bhattacharya and Sajeev John, Scientific Reports, 9, 12482 (2019).
2. „Photonic crystal light trapping: Beyond 30% conversion efficiency for silicon photovoltaics," S. Bhattacharya and Sajeev John, APL Photonics 5, 020902 (2020).
3. „Experimental demonstration of broadband solar absorption beyond the Lambertian limit in certain thin silicon photonic crystals," Mei-Li Hsieh, A. Kaiser, S. Bhattacharya, Sajeev John & Shawn-Yu Lin, Scientific Reports, 10, 11857 (2020).
4. "Light trapping by wave interference in silicon photonic crystal solar cells", S. Bhattacharya and Sajeev John, Solar RRL (submitted for publication)

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