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Plasmonic enhancement in perovskite solar cells: Optimized light absorption and efficiency via modified Ag nanobipyramids

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Abstract

Perovskite solar cells (PSCs), representing third-generation photovoltaic technology, show tremendous potential due to their high efficiencies. However, a primary challenge is enhancing light absorption without increasing the thickness of the active layer (AL). This study introduces the integration of modified silver (Ag) nanobipyramids (NBPs), applied in CH₃NH₃PbI₃-PSCs, and their light absorption enhancement efficiency was calculated using the finite element (FEM) method. We demonstrate that the plasmonic effects of modified Ag NBPs significantly enhance the J_{sc} 23.01 mA/cm² and power conversion efficiency (PCE) of the cells by 21.03 %. Further study shows that strategic variations in the depth, layers of Ag NBPs substantially boost light absorption. Finally, we discuss an optimization strategy for the arrangement of modified Ag NBPs within the AL. This

research introduces a new concept for advancing light absorption enhancement and PCEs in PSCs, and explores its potential for boosting the performance of various other types of solar cells. © 2025 Elsevier B.V.

Author keywords

Ag NBPs; Light absorption enhancement; Local surface plasmon resonance (LSPR); Perovskite solar cell (PSC); Power conversion efficiency (PCE); Simulation

Indexed keywords

Engineering controlled terms

Absorption efficiency; Conversion efficiency; Lead compounds; Plasmonics; Solar cells; Solar power generation; Surface plasmon resonance

Engineering uncontrolled terms

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Engineering main heading

Light absorption

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Abstract

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