

How do phonon bottleneck effects affect solar power generation?

To realize such ultraefficient solar cells, it requires that the excess energy of excited "hot" carriers is captured for power generation by reducing the rate of, or even preventing, carrier cooling. It has been known that phonon bottleneck effects (PBE) play the most decisive role in reducing the carrier thermalization rate.

How do phonon bottlenecks affect thermalization?

It has been found that phonon bottlenecks can play a key role in interrupting thermalization processes by restricting phonon interactions and their ability to dissipate hot carrier energy into the lattice. Several other mechanisms affecting thermalization could eventually be attributed to different types of phonon bottleneck effect.

1. Introduction

What causes a hot phonon bottleneck in organic-inorganic hybrid perovskite?

They also believe that the hot phonon bottleneck effect in the organic-inorganic hybrid perovskite material may be caused by the reflection and hence delay of the propagation of acoustic phonons, resulting in the conversion of multiple low-energy acoustic phonons into one high-energy optical phonon.

What is phonon bottleneck effect?

The overall process of phonon bottleneck effect could be described as below. When the phonon emission rate is larger than the LO phonon decay rate, an out of equilibrium phonon population is formed. The reabsorption of phonons by carriers is then more likely to take place than phonon decay.

Is hot phonon bottleneck effect enhanced in two-dimensional perovskite materials?

Ding et al. in their work in 2018 to study the relaxation process of carriers in the (BA)₂(MA)_{n-1}Pb_nI_{3n+1} series of two-dimensional perovskite materials, which was the first observation of the hot phonon bottleneck effect in the two-dimensional perovskite material is significantly enhanced compared to the three-dimensional perovskite [40].

What is a hot carrier solar cell?

The hot carrier solar cell aims to significantly boost the power conversion efficiency through fully utilizing the carrier thermalization energy loss. To realize such ultraefficient solar cells, it requires that the excess energy of excited "hot" carriers is captured for power generation by reducing the rate of, or even preventing, carrier cooling.

Perovskite solar cells have potential to deliver terawatt-scale power via low-cost manufacturing. However, scaling is limited by slow, high-temperature annealing of the inorganic transport layers and the lack of reliable, large-area methods for depositing thin (<30 nm) charge transport layers (CTLs). We present a method for scaling ultrathin NiO_x hole transport layers ...

The emerging perovskite solar cell (PSC) technology has attracted significant attention due to its superior power conversion efficiency (PCE) among the thin-film photovoltaic technologies. However, the toxicity of lead and poor stability of lead halide materials hinder their commercialization. In this case, after a decade of effort, various categories of lead-free ...

The hot carrier multi-junction solar cell (HCMJSC) is one of the promising advanced conceptual solar cells with theoretical efficiency greater than 65%, consisting of a thin top junction with a wide bandgap and a thicker junction at the bottom with a medium bandgap for absorption of high and low energy photo Celebrating Nanoscience in China

In this article, the purpose is to identify bottlenecks from a material techniques perspective, with the aim of promoting increased resources in the research of pertinent module ...

This discrepancy has put module manufacturers, especially those without their own cell production lines, in a difficult position, making it challenging to meet the demand for DCR modules effectively," Anurag Garg, CEO, Jakson ...

In recent years, the rapid development of organic and perovskite photovoltaic (PV) cells has transformed the renewable energy landscape, with widespread deployment ...

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The paper adds that existing lead-based perovskite solar cells are prevented from utilizing approximately 52% of total solar energy, as their absorption spectrum is limited to the visible light ...

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Firstly, a new bottleneck module is ... it is crucial to promptly and accurately detect defects in photovoltaic cells to ensure long-term stable operation of the PV power generation system.

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