Research on silicon-based high-efficiency solar energy materials and devices

Overview

Silicon remains the material of choice for photovoltaics because of its abundance, non-toxicity, high and stable cell efficiencies, the maturity of production infrastructure and the deep and widespread level of skill available in relation to silicon devices. Rapidly decreasing module prices mean that area-related balance of systems costs are an increasing proportion of photovoltaic systems price. This places a premium on efficient cells. In recent year. Silicon remains the material of choice for photovoltaics because of its abundance, non-toxicity, high and stable cell efficiencies, the maturity of production infrastructure and the deep and widespread level of skill available in relation to silicon devices. Rapidly decreasing module prices mean that area-related balance of systems costs are an increasing proportion of photovoltaic systems price. This places a premium on efficient cells. In recent years there have been large improvements in mass production of high quality wafers, the ability to handle thin wafers, maintenance of high minority carrier lifetimes, surface passivation, minimisation of optical losses, device characterisation and in other areas. Many of these improvements are viable in mass production. The upper limit of silicon solar cell efficiency is 29%, which is substantially higher than the best laboratory (25%) and large-area commercial (24%), cells. Cell efficiencies above 25% appear to be feasible in both a laboratory and commercial environment. Such a cell will have minimal bulk recombination due to a combination of a thin substrate with a very high minority carrier lifetime; superb surface passivation; small-area electrical contacts consistent with low contact recombination, free carrier absorption and contact resistance; excellent optical control through the use of texturing, antireflection coatings and rear surface reflectors; low edge recombination assisted by the use of thinner wafers, larger cells and edge passivation; and sufficient metal...

Article Content

A route towards high-efficiency silicon heterojunction solar cells

In this work, we propose a route to achieve a certified efficiency of up to 24.51% for silicon heterojunction (SHJ) solar cell on a full-size n-type M2 monocrystalline-silicon Cz ...

Efficiency enhancement of silicon-based solar cells by solar ...

In this study, we investigate the possibility of using a WS 2 /perovskite layer as an active layer in LSCs to enhance the performance of silicon-based solar cells. It was found ...

Strategies for realizing high-efficiency silicon heterojunction solar ...

Our research identifies two crucial requirements for optimizing (i)a-Si:H layers in high-efficiency SHJ solar cells: (i) achieving excellent surface passivation to minimize losses ...

A review of technologies for high efficiency silicon solar cells

This paper presents an overview of high-efficiency silicon solar cells'' typical technologies, including surface passivation, anti-reflection coating, surface texturing, multi-junction solar cell, and interdigitated back contact solar cell. The working principles, characteristics, and some recent research of these techniques are ...

A route towards high-efficiency silicon heterojunction solar cells

In this work, we propose a route to achieve a certified efficiency of up to 24.51% for silicon heterojunction (SHJ) solar cell on a full-size n-type M2 monocrystalline-silicon Cz wafer (total area, 244.53 cm 2) by mainly improving the design of the hydrogenated intrinsic amorphous silicon (a-Si:H) on the rear side of the solar cell ...

High-Efficiency Silicon Solar Cells—Materials and Devices Physics

This article reviews materials, devices, and physics of high-efficiency Si solar cells developed over the last 20 years and presents representative examples of superior performances and...

High-Efficiency Silicon Heterojunction Solar Cells: Materials, Devices ...

This article reviews the development status of high-efficiency c-Si heterojunction solar cells, from the materials to devices, mainly including hydrogenated amorphous silicon (a-Si:H) based silicon heterojunction technology, polycrystalline silicon (poly-Si) based carrier selective passivating contact technology, metal compounds and ...

Status and Progress of High-efficiency Silicon Solar Cells

In this chapter, we explain the most important properties of every material that serve as indispensible part of Si-based solar cell to contribute to high efficiency, and shed a ...

High-Efficiency Solar Cells: Physics, Materials, and Devices

As part of the effort to increase the contribution of solar cells (photovoltaics) to our energy mix, this book addresses three main areas: making existing technology cheaper, promoting advanced technologies based on new architectural designs, and developing new materials to serve as light absorbers. Leading scientists throughout the world ...

Strategies for realizing high-efficiency silicon heterojunction solar ...

Our research identifies two crucial requirements for optimizing (i)a-Si:H layers in high-efficiency SHJ solar cells: (i) achieving excellent surface passivation to minimize losses induced by surface recombinations, and in the meanwhile (ii) ensuring high bulk quality for uninterrupted charge carrier collection.

High-efficiency crystalline silicon solar cells: status and ...

This article reviews the dynamic field of crystalline silicon photovoltaics from a device-engineering perspective. First, it discusses key factors responsible for the success of the classic dopant-diffused silicon homojunction solar cell. Next it analyzes two archetypal high-efficiency device architectures – the interdigitated back ...

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In this chapter, we explain the most important properties of every material that serve as indispensible part of Si-based solar cell to contribute to high efficiency, and shed a light on some of the most important points and subjects raised in individual contributions, and also give a brief survey of relevant research efforts in a broader context.

High Efficiency Silicon Solar Cells

Given the attractive attributes of crystalline silicon summarised above, two prospective routes to higher efficiency are improved cell design and fabrication, and tandem cells based on silicon. In a silicon tandem structure, an additional cell fabricated from a material with a different bandgap would be placed either in front of or ...

High-Efficiency Silicon Solar Cells—Materials and Devices Physics

Boron laser doping (LD) is a promising technology for high-efficiency solar cells such as p-type passivated locally diffused solar cells and n-type Si-wafer-based solar cells. We produced a printable ...

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