Photovoltaic effect in ferroelectric materials

What is the ferroelectric photovoltaic effect?

To overcome these limitations,another mechanism was discovered in noncentrosymmetric materials,such as ferroelectrics and is called the ferroelectric photovoltaic effect (FEPV),which differs from the conventional junction-based interfacial PV effect in semiconductors,such as p-n junction or Schottky junction.

Can ferroelectric materials be used for photovoltaics?

Ferroelectric materials for photovoltaics have sparked great interest because of their switchable photoelectric responses and above-bandgap photovoltages that violate conventional photovoltaic theory. However,their relatively low photocurrent and power conversion efficiency limit their potential applicationin solar cells.

What is bulk ferroelectric photovoltaic effect (bfpve)?

Bulk ferroelectric photovoltaic effect (BFPVE) is a fascinating phenomenon with many unique features,such as extremely large photovoltage,where a photocurrent is proportional to the polarization magnitude and charge carrier separation in homogeneous media (Ji et al.,2010).

What is photovoltaic effect in ferroelectric thin film?

In other words,this effect is associated with the absence of inversion symmetryin the distribution of defects,impurities,space charges and polarizations in ferroelectric materials. Figure 6.4. Schematic illustration of mechanism of photovoltaic effect in ferroelectric thin film.

What is PV effect in ferroelectric ceramics?

The PV effect in ferroelectric ceramics (bulk) and single crystals such as BaTiO 3,Pb (Zr,Ti)O 3,and LiNbO 3 were observed earlier (Glass et al.,1974,Brody,1973,Nonaka et al.,1995). The noncentrosymmetric nature of the unit cellgives rise to this effect (Fridkin,1979,Vladimir and Popov,1978).

Where does the ferroelectric photovoltaic (Fe-PV) effect originate?

The ferroelectric photovoltaic (FE-PV) effect originates from the spontaneous polarization in ferroelectric material[16,17].

The bulk photovoltaic effect that is intimately associated with crystalline symmetry has been extensively studied in various nonmagnetic materials, especially ferroelectrics with a switchable electric polarization. In order to further engineer the symmetry, one could resort to spin-polarized systems possessing an extra magnetic degree of freedom. Here, we investigate ...

The effect is symmetry driven and fundamentally relevant in all ferroelectrics, including BTO. In conjunction, the systematic long-range ordering of ions associated with SLs, while the strain maintained, has been also proposed as a ...

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Meanwhile, photovoltaic effect is firstly observed in the R-OABHI based solar cell with an open-circuit voltage of 0.581 V and a short-circuit current density of 1.734 mA/cm 2. Overall, we establish a new approach for realizing metal-free ferroelectric photovoltaics, and it will pave the way for the exploration of multifunctional chiral ...

1 Introduction. Ferroelectrics constitute a class of materials wherein spontaneous polarization can be reversed within crystals lacking centrosymmetry. [] The control of ferroelectric domains has long been a subject of understanding because it forms the basis of electrical/mechanical conversion characteristics, [] memory operation, [] and so on in many ...

Ferroelectric materials can display a spontaneous polarization due to the noncentrosymmetry of crystallographic unit cell, ... In this review, we refer to the solar cells based on both ferroelectric and photovoltaic effects of photoferroelectric perovskites as the photoferroelectric perovskite solar cells (PPSCs), and summarize the recent ...

The bulk photovoltaic effect (BPE) has drawn considerable attention due to its ability to generate photovoltages above the bandgap and reports of highly enhanced photovoltaic current when using nanoscale absorbers or nanoscale electrodes, which, however, do not lend themselves to practical, scalable implementation. ... In a bulk ferroelectric ...

Ferroelectric materials have been a focus of much research over the last few decades for their unique piezoelectric and optoelectronic properties. Conventional solar cells have been devised based on the photovoltaic effect of semiconductor p-n junctions, with their photogenerated voltage being influenced by the bandgap of the semiconductors, limiting their further ...

Ferroelectric materials exhibit a PV effect, called the bulk photovoltaic (BPV) effect (6, 7), that is distinct from that of p-n junctions.Under uniform illumination, a homogeneous ferroelectric material gives rise to a current under zero bias [short-circuit current (I SC)] that depends on the polarization state of the incident light and produces an anomalously large ...

1. Introduction. Driven by the energy crisis all over the world, more and more researchers have begun to investigate a broad spectrum of candidate materials for thin-film photovoltaic cells as a renewable energy production [1, 2, 3].Among them, ferroelectric photovoltaic effect has been received considerable attention in the past few years because of ...

Ferroelectric photovoltaics, as a new type of solar cell, relying on an internal electric field instead of p-n or Schottky junctions, can considerably improve the efficiency of charge separation and migration. ... a School of Materials Science and Engineering, Shanghai Institute of Technology, ... A bulk photovoltaic effect was observed in ...

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The power conversion efficiency (PCE) of ferroelectric photovoltaics (FePvs) was originally not expected to surpass 0.01%, but since FePv efficiencies now exceed this limit by nearly 3 orders of magnitude, FePvs warrant further investigation. Ferroelectricity occurs exclusively in materials with a polar crystal structure where the spontaneous polarization can be reoriented with an ...

The discovery of photovoltaic effect in ferroelectric materials can be traced back to more than 50 years ago (1-3). In contrast to classical semiconductor solar cells, photoexcited carriers in ferroelectric materials are spontaneously separated due to the inversion symmetry breaking. The fundamentally different mechanism endows ferro-

Bulk photovoltaic effect, which arises from crystal symmetry-driven charge carrier separation, is an intriguing physical phenomenon that has attracted extensive interest in ... Whereas conventional ferroelectric materials mostly suffer from extremely low photocurrent density and weak photovoltaic response at visible light wavelengths. Emerging ...

On the other hand, bulk photocurrent can be induced by high-energy light illumination even in good insulators; and directional photocurrent without external bias [that is, a photovoltaic (PV) effect] has been studied in ferroelectrics (5-13).When a ferroelectric in an open circuit is illuminated by ultraviolet light, for example, a high photovoltage, much larger than the band ...

The ferroelectric photovoltaic (FE-PV) effect originates from the spontaneous polarization in ferroelectric material [16, 17]. In addition, a unique and important characteristic of the FE-PV devices is the anomalous photovoltaic (APV) effect, which refers to the open-circuit voltage (V OC) can be a few orders of magnitude larger than the ...

It has been demonstrated that the polarization-induced electric field intensity of ferroelectric materials is approximately 1-2 orders of magnitude higher than traditional semiconductor p-n junctions, 43 and the electric field width spans the entire ferroelectric layer. 44 In the ferroelectric film, the photovoltaic effect or photo-current ...

The photovoltaic (PV) effect in ferroelectric (FE) materials has been known for many decades, but only a limited number of studies are available in the literature. Due to ever-increasing global concern of environmental degradation from conventional energy sources, the research for clean and sustainable energy has been directed to some extent to ...

Recent developments in photovoltaic materials have led to continual improvements in their efficiency. We review the electrical characteristics of 16 widely studied geometries of photovoltaic materials with efficiencies of 10 to 29%.

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Ferroelectric materials exhibiting anomalous photovoltaic properties are one of the foci of photovoltaic research. We review the foundations and recent progress in ferroelectric materials for photovoltaic applications, including the physics of ferroelectricity, nature of ferroelectric thin films, characteristics and underlying mechanism of the ferroelectric ...

Therefore, the search for materials with greater remanent polarization and narrower bandgap becomes the key to regulating the ferroelectric photovoltaic effect. In the ferroelectric photovoltaic materials with the structure of ABO 3, due to the strong orbital hybridization between the B-O bonds, the material has a wide bandgap, which can only ...

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