Method for Maximizing Current Density and Voltage in Oxygen vacancy Controlled Bismuth Ferrite Based Thin Film Solar Cells

IITM Technology Available for Licensing

Problem Statement

- **BiFeO3-based solar cells** struggle with **low current output (JSC)**, **limiting their efficiency** despite having a high VOC.
- The **Impact of oxygen vacancies** on both BiFeO3's properties & solar cell performance remains unclear, showing **significant hurdle in optimizing these devices.**
- **Balancing high JSC** (mA/cm2) with sustained **VOC** (volts) in BFO-based solar cells requires fine-tuning film thickness, electrode setup, and doping methods, **posing a crucial challenge**.
- Hence, the present patent is needed, to **enhance the efficiency of BiFeO3 solar cells by overcoming JSC limitations** while keeping a high VOC, promising improved performance in photovoltaic uses.

Technology Category / Market

Categories: Electronics & Circuits | Energy, Energy Storage & Renewable Energy

Industries: Renewable Energy, Solar Power, Electronics and Semiconductor Manufacturing

Applications: Photovoltaic Systems, Solar Power generation, Renewable Energy

Market: The Global Solar Cells Market was valued at **$ 85 Bn in 2021** and is expected to reach **$ 317.93 Bn by 2030**, growing at **15.8% CAGR** from **2021 to 2030**.

Intellectual Property

IITM IDF No: **1928;** IP No: **404099 (**Granted)

TRL (Technology Readiness Level)

TRL-5 Validation in Relevant Environment

Research Lab

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Technology

The present patent technology discloses a **Method** for Maximizing Current Density and Voltage in Oxygen Vacancy Controlled Bismuth ferrite based thin film solar cells.

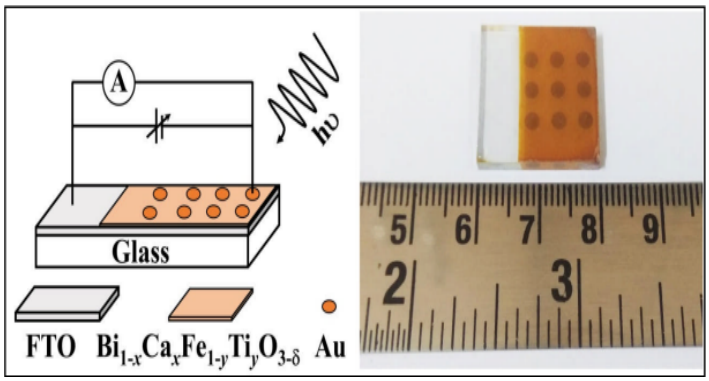

FIG 1 represents of FTO/Bi1-xCaxFe1-yTiyO3--/Au devices. The method disclosed involves a **multifaceted approach to enhance the performance of solar cells using BiFeO3:**

Material Modification: Implementing techniques such as doping or compositional alterations to tailor the properties of BiFeO3, optimizing its ferroelectric behavior & enhancing its suitability for photovoltaic applications**.**

Device Fabrication: Experimenting with various fabrication methods to create BiFeO3-based solar cell devices, including exploring different film thicknesses, electrode configurations, and interfaces to improve charge carrier separation and collection.

Oxygen Vacancy Analysis: Investigating the influence of oxygen vacancies on ferroelectric properties and solar cell performance of BiFeO3, potentially leveraging these vacancies to boost device functionality.

Performance Evaluation: Rigorous testing and analysis of the solar cell devices to quantify their short circuit current density (JSC) and open circuit voltage (VOC), aiming to optimize these parameters higher photo-conversion efficiency.

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Key Features / Value Proposition

User Perspective:

- Improved conductivity & photoconductivity; Better device efficiency & responsiveness.
- Consistent performance under varying conditions ensures reliability for users.
- Energy is harvested by its Photovoltaic property, reducing dependence on external power sources, provides energy efficiency.
- Customization with different compositions offer flexibility for specific user needs.

Technology Perspective:

- Use of RF sputter deposition for producing capacitor-like devices with varying compositions.
- Introducing oxygen vacancies by substitutions (Ca and Ti) enhances performance.
- Thin film technology suitable for various electronic and photovoltaic applications.

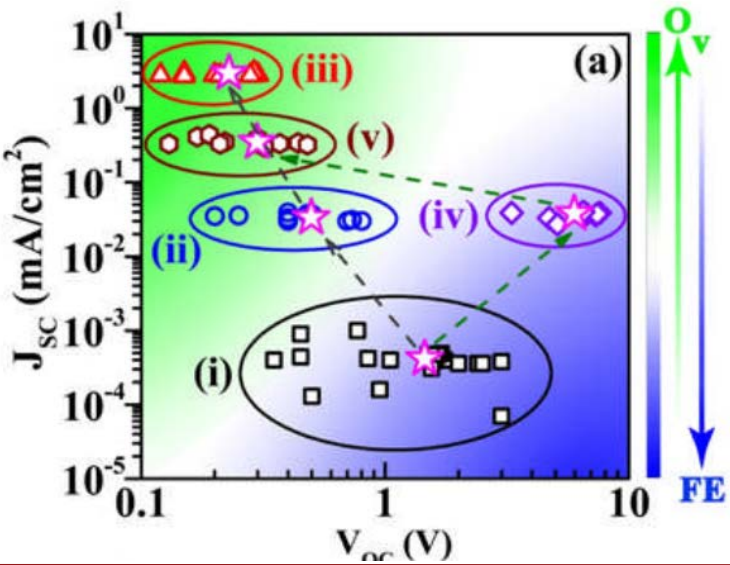
Industrial Perspective:

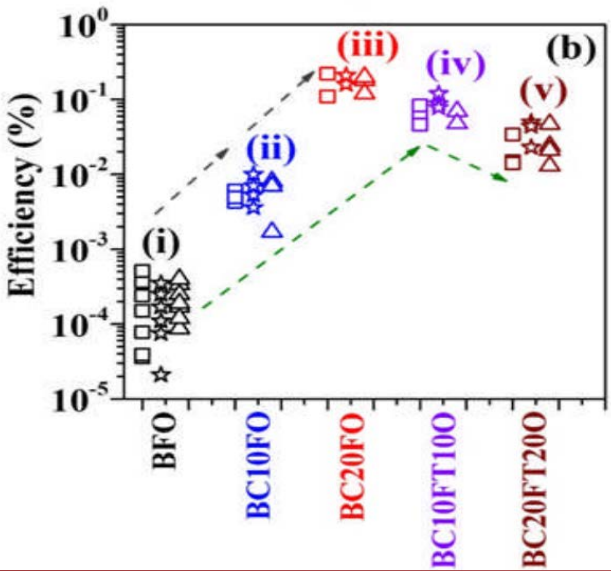
- Advanced performance & reliability could spot the product favorably against competitors.
- Manufacturing process feasibility for large-scale production ensures commercial viability.
- Meeting industry standards & regulations ensures market acceptance & trustworthiness.

FIG 2 represents **JSC, VOC, and efficiency values** obtained from various device structures.

(a) Average VOC and JSC values for each set of devices are shown by star open symbol.

(b) Efficiencies are plotted for devices tested in three different batches. First, second and third batches are denoted as square, star and triangular open symbol.





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