Trinity College Dublin
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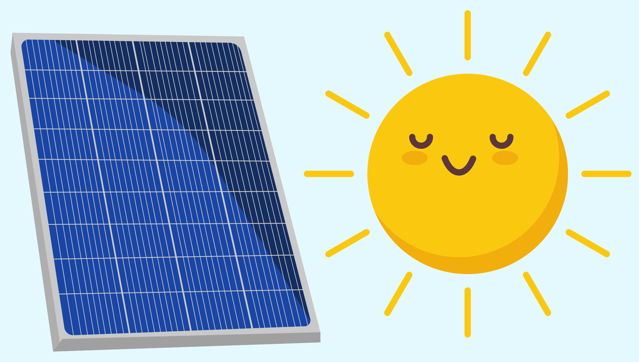
Investigating the implementation of Nanomaterials in Perovskite Solar Cells (PSCs) and their ability to enhance the cell's stability, efficiency, durability and large-scale application



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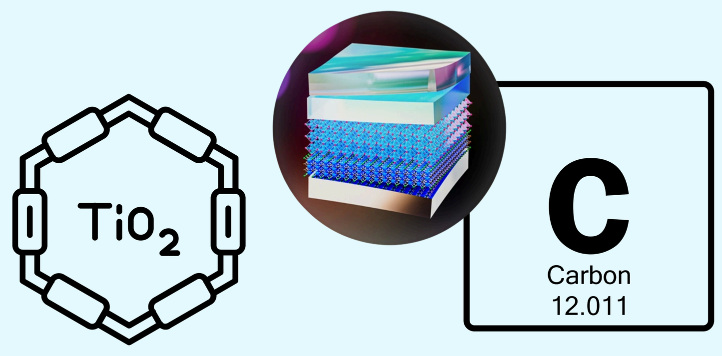

1 What are Perovskite Solar Cells (PSCs)?

PSCs are a form of photovoltaic (PV) cells based on the Perovskite compound. This material is arranged in an ABX_3 structure (1). The most common forms of the compound are **methylammonium lead iodide** and **formamidinium lead iodide** (2). These compounds are renowned for properties such as high carrier mobility and high light absorption coefficients (3), all of which are key in helping achieve **25% power conversion efficiency (PCE)** (4). However, issues such as **environmental toxicity** and **limited durability and stability** have prevented its widespread usage (7, 8).

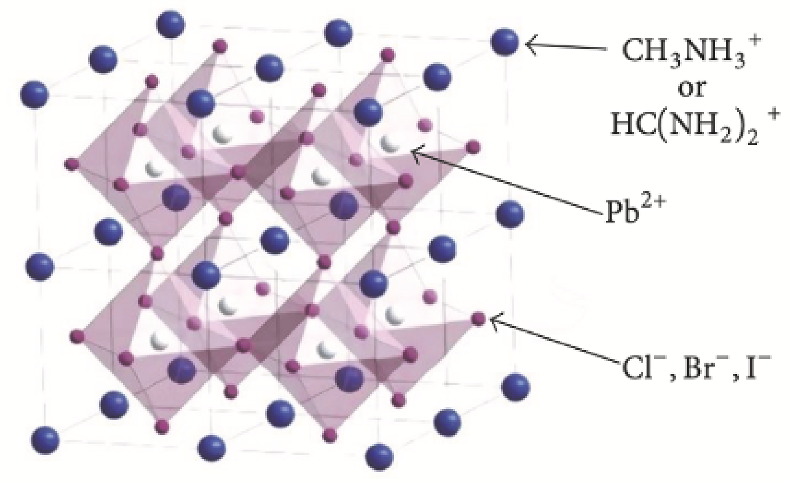

FIGURE 1: PEROVSKITE ATOMIC STRUCTURE (5)

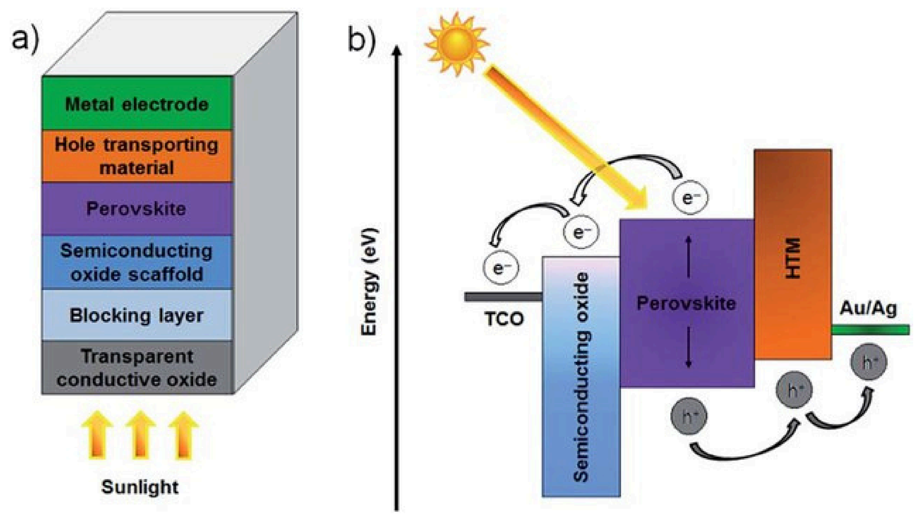

FIGURE 2: STRUCTURE OF PSCS (6)

2 Role of nanomaterials

Nanomaterials, which contain structures with **dimensions between 1 and 100 nm** (9), have shown to improve key performance metrics of PSCs when used in layers such as the charge-carrier transport layers and the electrodes.

THE QUESTION THAT REMAINS:

Can these materials **improve** the **properties** of PSCs when used in the **Perovskite layer** and which material is the **most effective** from a **device performance**, **economic** and **environmental** perspective?

3 Methodology and findings

60 laboratory-constructed cells analysed through literature

4 categories of nanomaterials analysed and reviewed

FULL RESEARCH REPORT

Nanomaterial	Average Power Conversion Efficiency (%)	Ranking for stability and durability across various conditions	Average cost of additive (€/mg)	Potential environmental hazards	Can also it help reduce lead leakage?
TiO_2 nanoparticles	14.65	4	0.45	Poses soil contaiminantion risk	Unknown
MXene nanosheets	17.70	1	1.02	Use of toxic chemicals and high electricity consumption for synthesis, but can be recycled	Yes
Graphene	16.52	2	0.68	Extremely high electricity consumption	Unknown
Carbon nanotubes (CNTs)	17.08	2	0.62	Produces harmful byproducts during synthesis, but can be recycled	Yes
Carbon Quantum Dots (CQDs)	16.80	3	6.40	Use of toxic chemicals and high electricity consumption for synthesis, but can be recycled	Yes

4 Future work

This study has shown nanomaterials' capability of enhancing the electrical output of PSCs, as well as their performance period. However, while these nanomaterials have shown promising results in terms of ameliorating the performance characteristics of PSCs, further research must be conducted into acquiring more environmental friendly synthesis methods. One can agree that these materials can only assist PSCs in becoming a bigger player in the solar industry.

5 References

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