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Low-cost silicon heterojunction solar cells fabrication based on carrier selectivity

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Abstract

Silicon heterojunction solar cells having power conversion efficiency of >15% fabricated at room-temperature by the NiO_x and LiF_x as hole- and electron-selective layers.

This approach avoids;

(a) High temperature diffusion process in conventional solar cells,

(b) Use of toxic gases and complex fabrication process steps.

Introduction

Motivation

- To meet world energy demand and to mitigate environmental challenges, abundant and free solar energy is one of the options.
- Silicon-based solar cells dominate market; Due to material stability, abundance and well-established microelectronics industrial processes.
- Carrier-selective contact based silicon solar cells is a novel concept.

Experimental details

Si wafer surface preparation	
Chemical treatment	Piranha,RCA-2

NiOx deposition (side 1)	
Thermal evaporation	Thickness= 10 nm

LiFx deposition (Side 2)	
Thermal evaporation	Thickness= 1 nm

Back contact (Aluminium)	
Thermal evaporation	Thickness= 300 nm

Indium Doped tin Oxide (ITO)	
RF- Sputtering	Thickness=70 nm

Front contact	
Silver	Thickness= 300 nm

Results

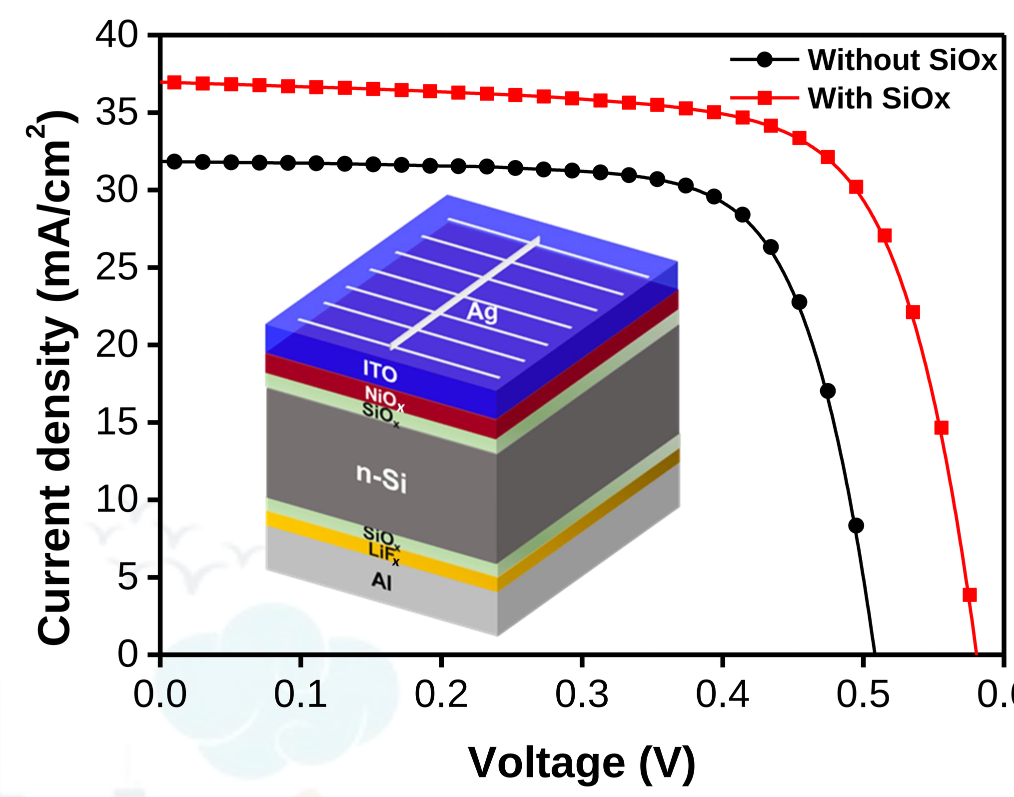

Fig.1 Light J-V plots with & without SiO_x layer.

Table: Solar cell parameters

PV Parameter / Cell type	Without SiO_x	With SiO_x
V_{oc} (mV)	510	580
J_{sc}(mA/cm²)	34.29	36.90
FF (%)	71.08	71.06
Efficiency (%)	12.45	15.26
R_s (Ω-cm²)	1.48	1.62
R_{sh} (Ω-cm²)	439	415

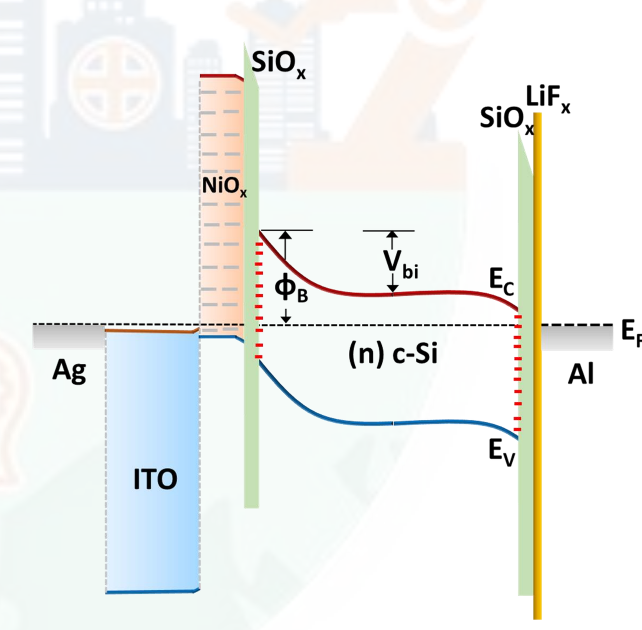

Fig.2 Energy band diagram of NiO_x carrier selective contact Si solar cell

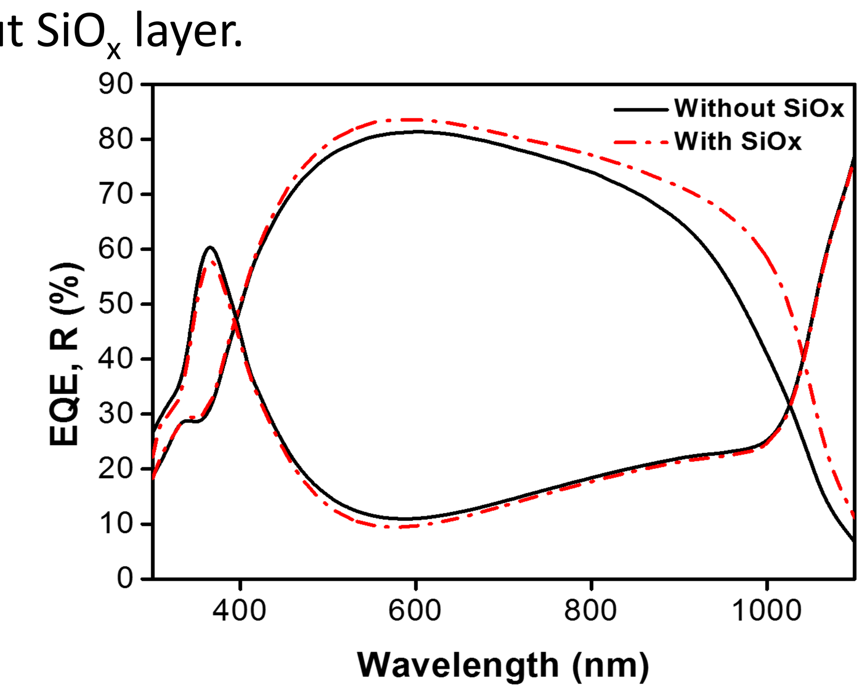

Fig.3 EQE and reflectance with and without SiO_x interlayer solar cell.

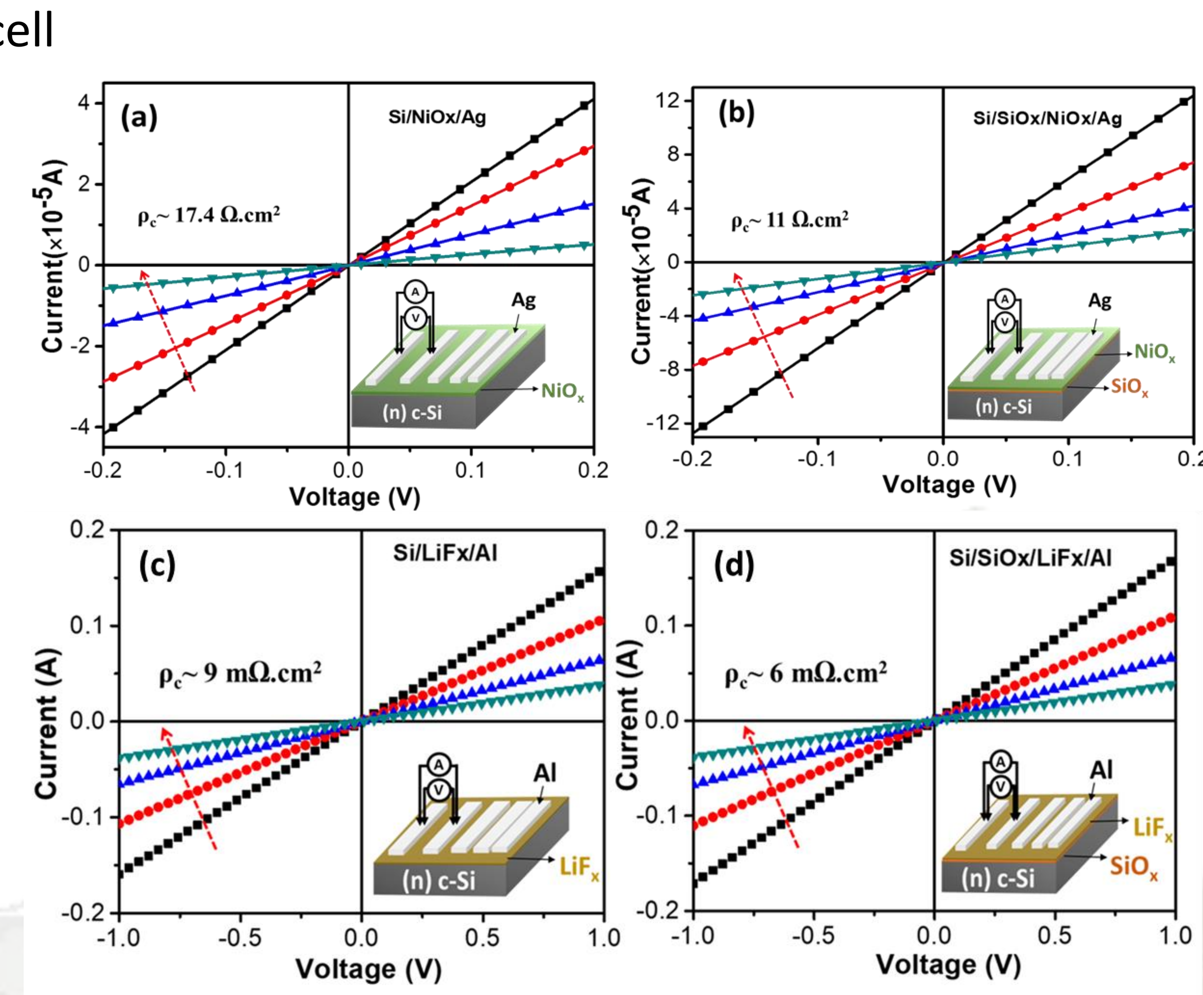

Fig.4 Current-voltage characteristics of various configurations for quantifying contact resistivity after the NiOx/LiFx formation on the silicon by transfer length method (TLM).

Conclusions

- Highest conversion efficiency of >15% is achieved first time in the world.
- Working towards ~18% cell by understanding optical/electrical losses of device and further ~20% efficient cell with some more better insights on the device analysis using various electrical characterization techniques.

Industrial Significance

- With an initial effort, we fabricated record conversion efficiency of >15% solar cell first time, and eagerly looking forward for >20% with the better device interface engineering to demonstrate an industrial relevance.

Technology Readiness Level:: *5 (Validated at Relevant Environment)*

References

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Department Name