Thickness Dependence of Window layer on $CH_3NH_3PbI_{3-x}Cl_x$ Perovskite Solar Cell

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INTRODUCTION:

- The demand for energy is on an increasing trend.
- The oil reservoirs, coal as well that of the gas will completely be exploited in the near future.
- There is need to find *clean, renewable and sustainable alternative source of energy*.
- Solar energy has for a long time been considered among the best alternative source of energy owing to its abundance but harvesting and conversion technology has been the limiting factor.
- For decades, silicon has remained the dominant material for production of commercial solar conversion devices.
- Research seems to suggest that perovskites stand to be good candidates among other materials.
- The understanding of the operational mechanism of the PSCs is necessary for further improvement of its efficiency.

Numerical Model for the Perovskite Solar Cell and Material Parameters

- The designing and characterizing of $CH_3NH_3PbI_{3-x}Cl_x$ PSC model was done using the simulation tool SCAPS-1D.
- The solar cell structure consists of FTO /TiO_2 multilayer films on glass substrate, $CH_3NH_3PbI_{3-x}Cl_x$ absorber layer, a Spiro-OMeTAD hole transport layer and silver back contact as shown in figure 1.

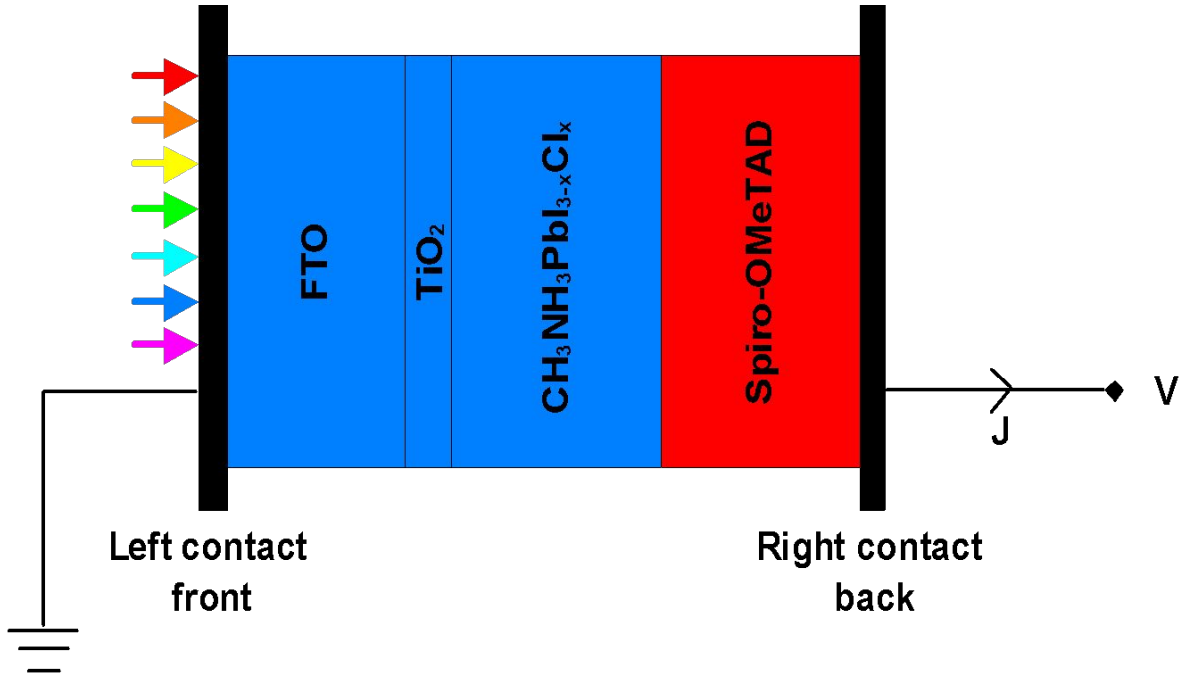


Figure 1. $CH_3NH_3PbI_{3-x}Cl_x$ perovskite solar cell architecture.

- The device output performance was majorly based on the electrical, optical, material, and device parameters that were used in simulation.

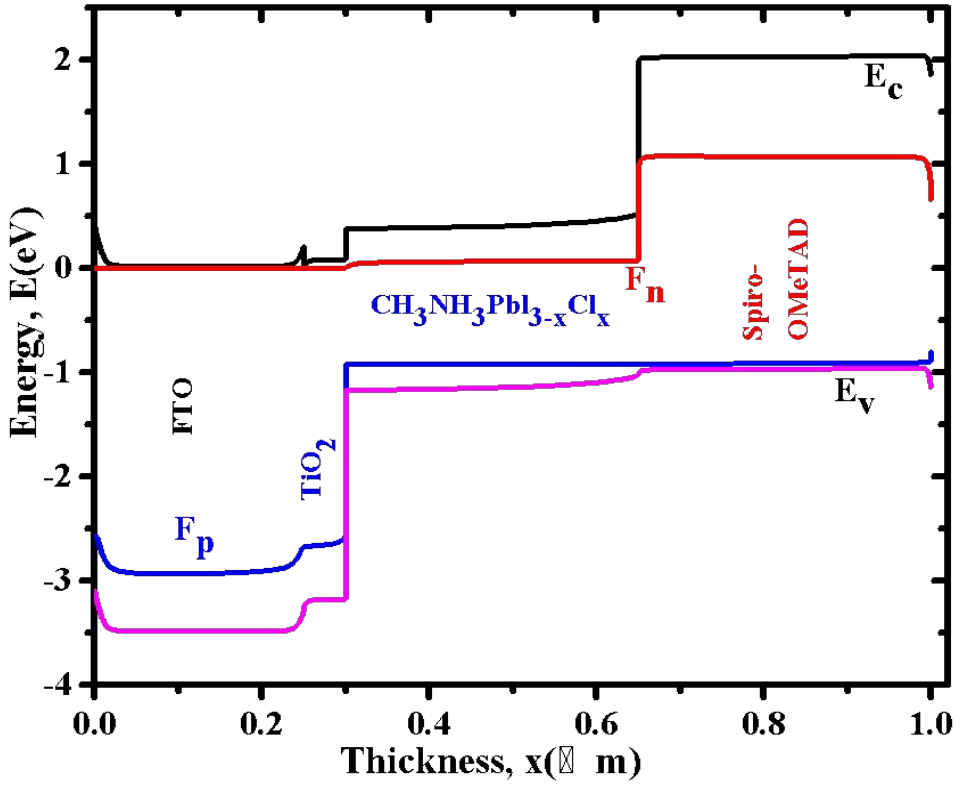


Figure 2. Energy Band Structure for the Solar Cell

Results and Discussion

1. Effect of FTO Thickness

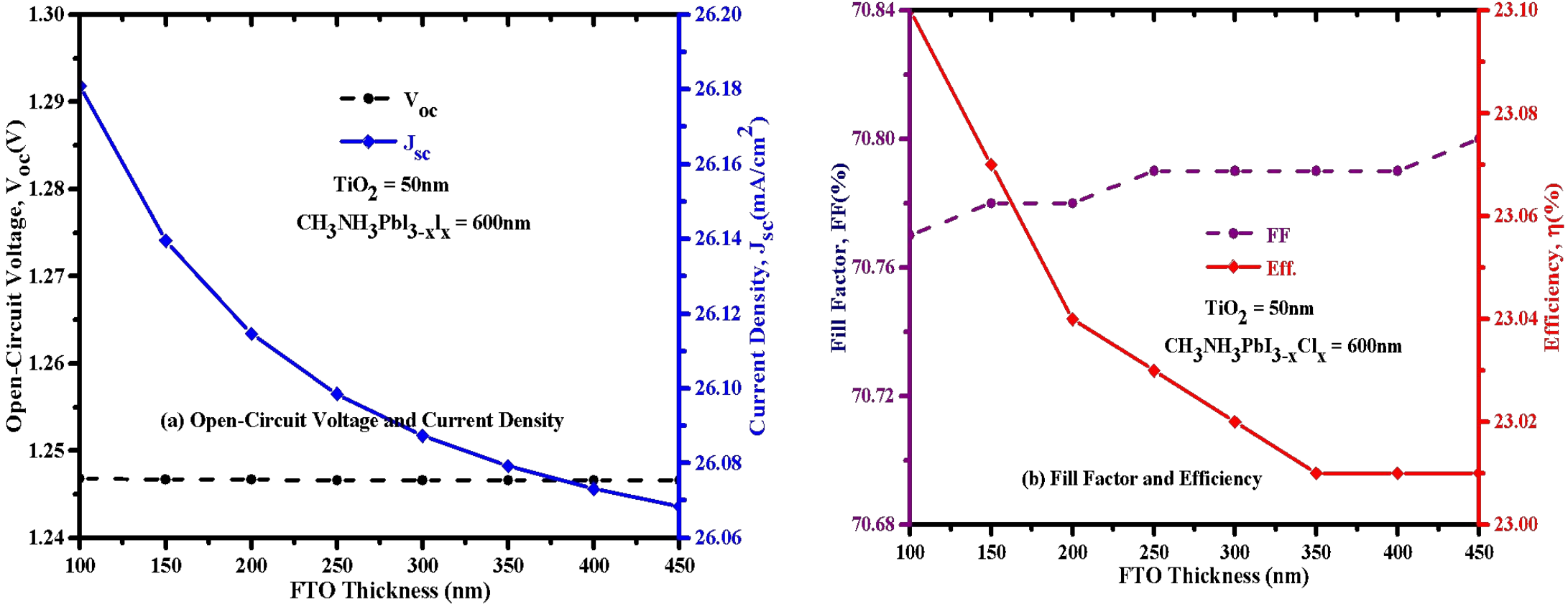
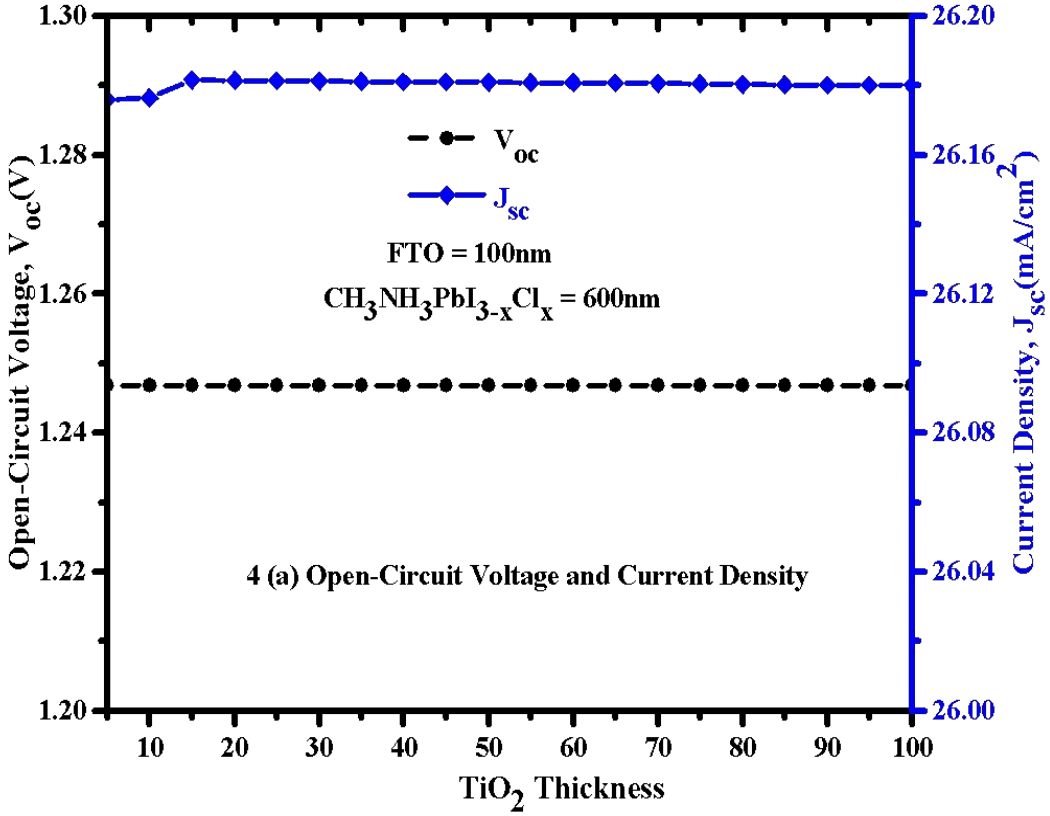


Figure 3. (a) Open- circuit and Current Density (b) Fill Factor and Efficiency as functions of FTO thickness for constant TiO_2 and $CH_3NH_3PbI_{3-x}Cl_x$ thicknesses.

Results and Discussion cont'd…

2. *Effect of TiO_2 Thickness*



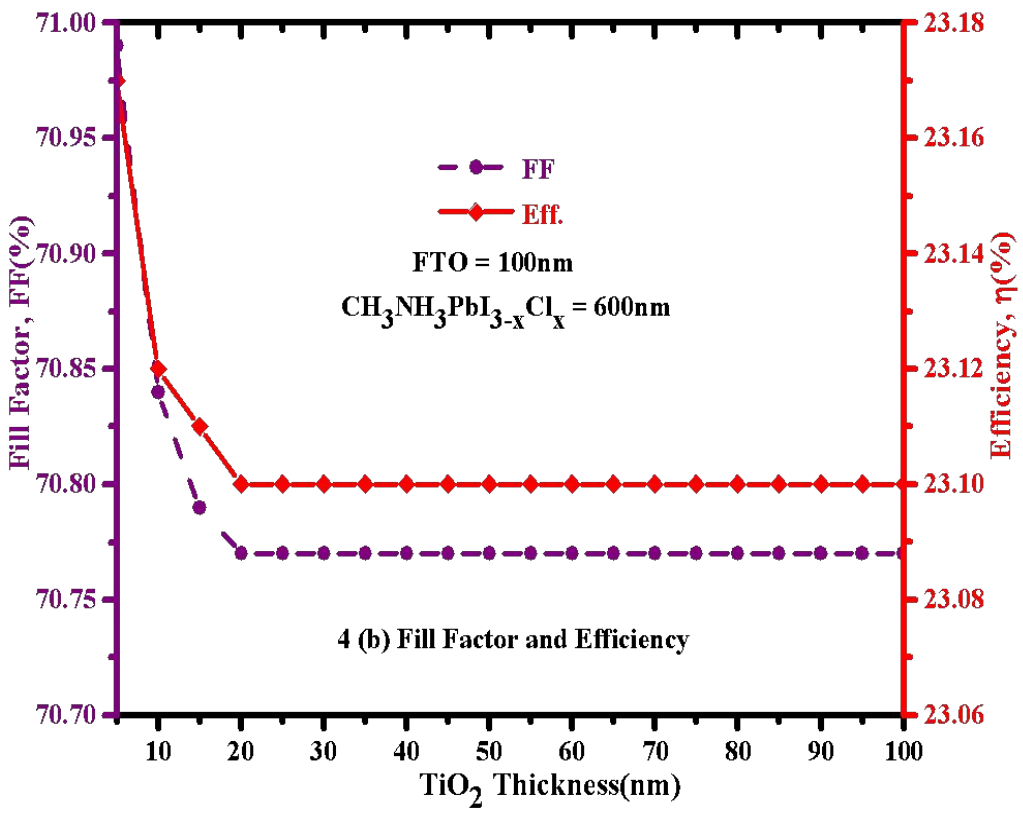
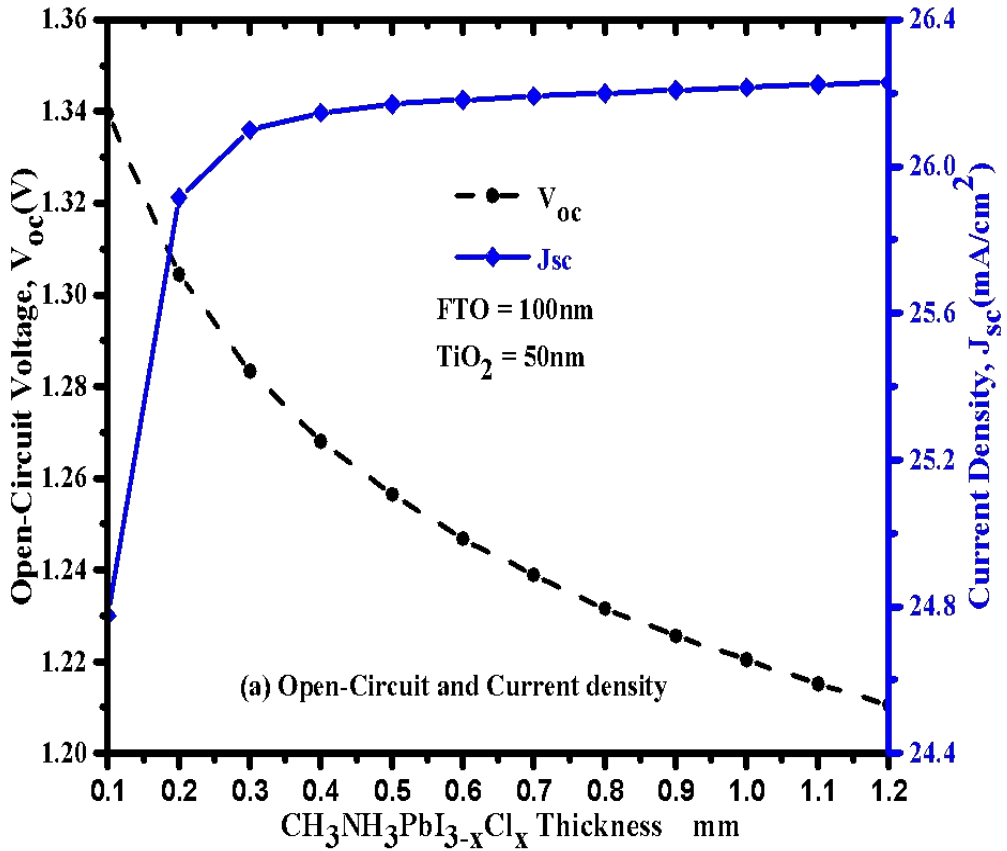


Figure 4. (a) Open- circuit and Current Density (b) Fill Factor and Efficiency as functions of TiO_2 thickness for constant FTO and $CH_3NH_3PbI_{3-x}Cl_x$ thicknesses.

Results and Discussion cont'd…

3. *Effect of $CH_3NH_3PbI_{3-x}Cl_x$ Thickness*



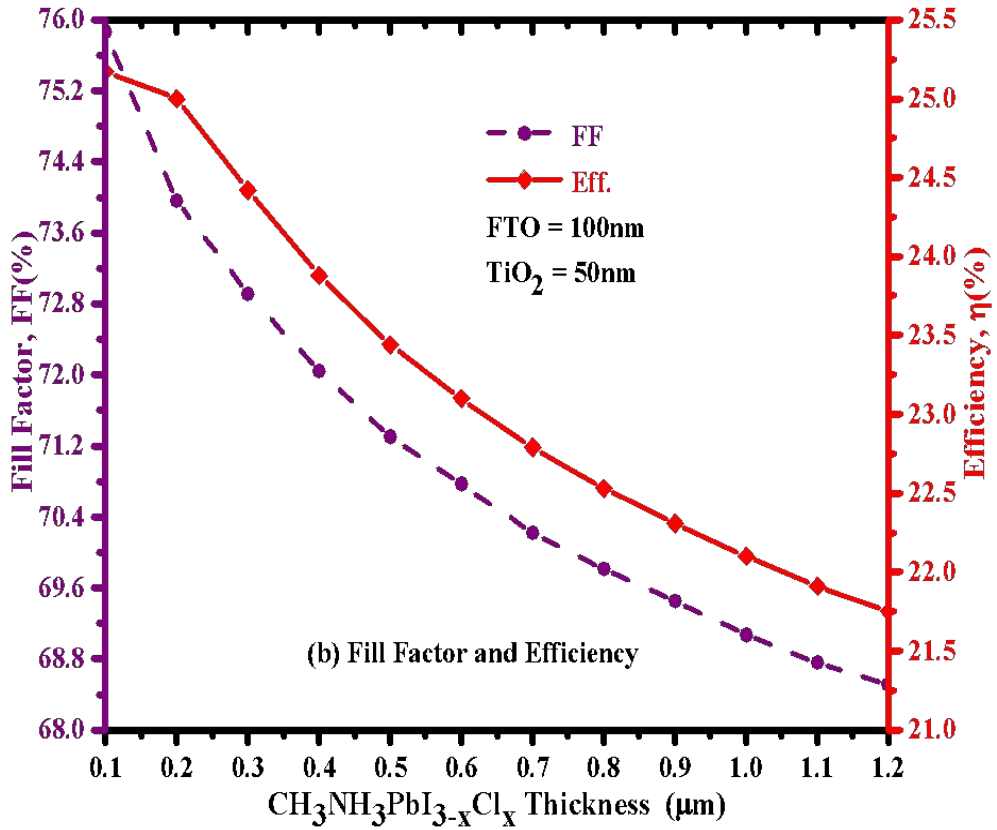


Figure 5. (a) Open- circuit and Current Density (b) Fill Factor and Efficiency as functions of $CH_3NH_3PbI_{3-x}Cl_x$ thickness for constant FTO and TiO_2 thicknesses.

Results and Discussion cont'd…

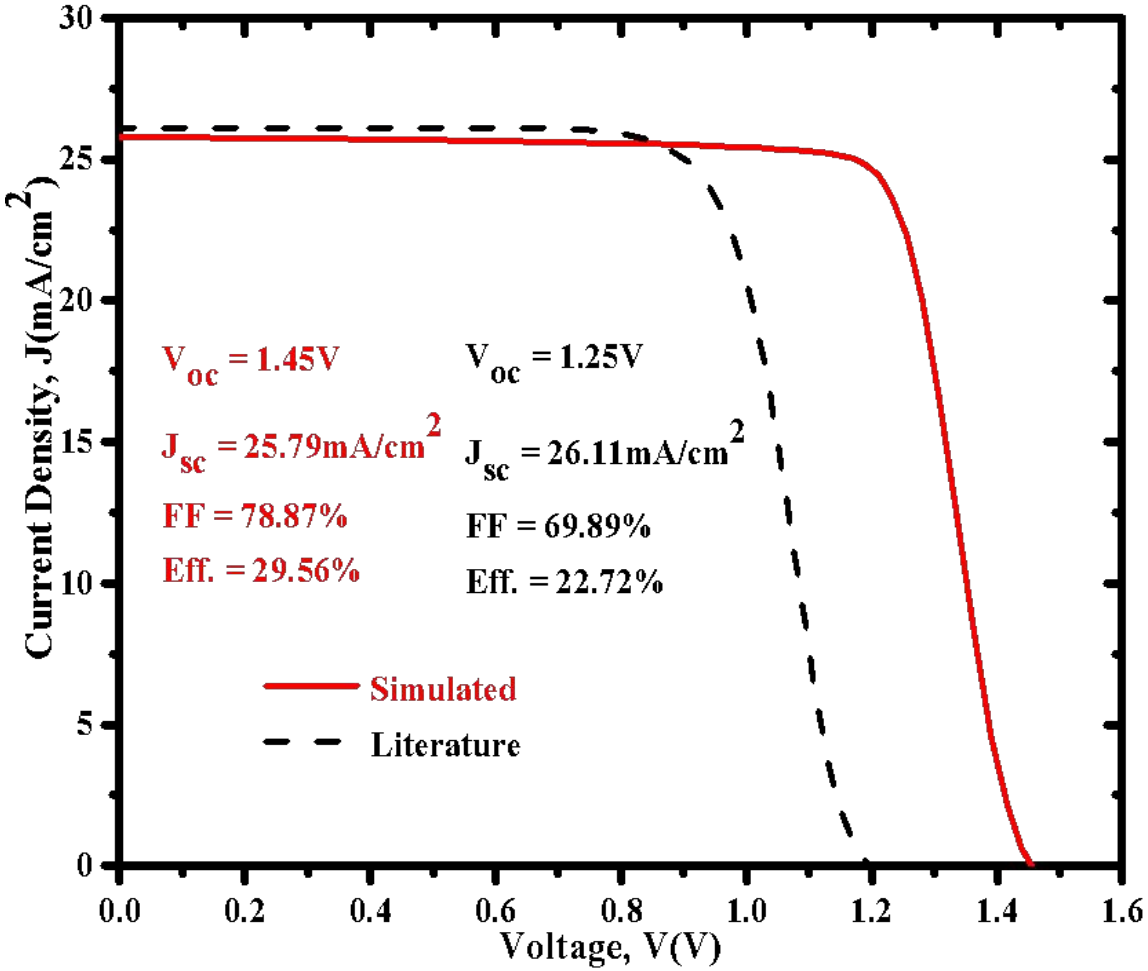


Figure 6. J-V characteristics of the cell.

Conclusion

- The perovskite solar cell with the structure glass/FTO/TiO_2/ $CH_3NH_3PbI_{3-x}Cl_x$ /Spiro-OMeTAD/Ag was successively simulated using SCAPS-1D software.
- FTO, TiO_2 and $CH_3NH_3PbI_{3-x}Cl_x$ thicknesses were varied to investigate their influence on the device performance.
- The simulation revealed that variation of TiO_2 thickness has no significance change in the device performance, and an absorber thickness from 300nm to 400nm is suitable for better device performance and hence thicker absorber may have no much advantages.
- The simulation results further revealed that 100nm, 50nm and 300nm layer thickness for FTO, TiO_2 and $CH_3NH_3PbI_{3-x}Cl_x$ respectively gave a better cell performance as compared to 200nm, 50nm and 600nm layer thickness for FTO, TiO_2 and $CH_3NH_3PbI_{3-x}Cl_x$ reported in literature.

ACKNOWLEDGEMENT

- *Dr. Marc Burgelman and his staff at the University of Gent, Belgium, for the freely distributed SCAPS-1D simulator.*

THANK YOU!