Research Center for Photovoltaics

ペロブスカイト太陽電池における電子輸送層界面の制御

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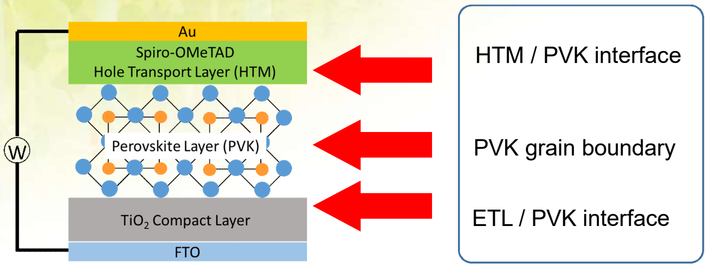
Introduction



Scheme 1. Structure of the PSC in this study

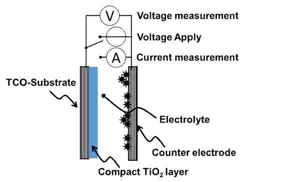
- Efficient charge transfer from the perovskite layer is important to enhance the power conversion efficiency (PCE).
- Charge transfer between the compact TiO_2 and the perovskite layer is inefficient.[1]
- $TiCl_4$ treatment on the compact TiO_2 layer may enhance the PCE.[2]
- Conduction band edge (CBE) potential of the compact TiO_2 layer possibly be shifted with the $TiCl_4$ treatment.
- In this study, conduction band edge tuning of compact TiO_2 layer with $TiCl_4$ treatment was examined and the solar cell performance was observed.

1. K. Wojciechowski, S. D. Stranks, A. Abate, G. Sadoughi, A. Sadhanala, N. Kopidakis, G. Rumbles, C-Z. Li, R. H. Friend, A. K.-Y. Jen, H. J. Snaith, *ACS Nano*, 8, 12701-12709 (2014).
2. L. Cojocaru, S. Uchida, Y. Sanehira, J. Nakazaki, T. Kubo, H. Segawa, *Chem. Lett.* 44, 674–676 (2015).

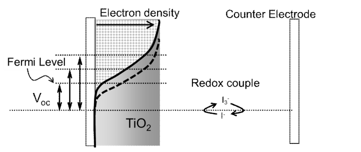
Experiment

Electrochemical measurement for conduction band edge evaluation:

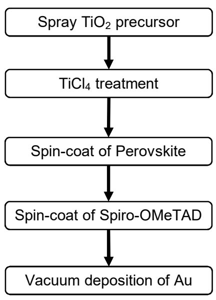
- The sandwich cell with compact TiO_2 substrate and platinized counter electrodes was fabricated and iodide / tir-iodide electrolyte was injected between two electrodes.
- Relation between open circuit voltage (Voc) and electron density was measured with charge extraction methods.



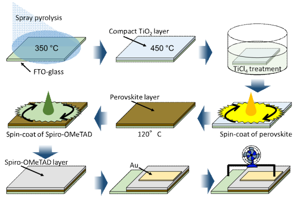
Scheme 2. The electrochemical cell for the charge extraction measurement.



Scheme 3. Evaluation of the conduction band edge with the charge extraction method.



Scheme 4. The flow chart of the cell fabrication.



Scheme 5. Fabrication process of the cells.

Acknowledgement

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Results and discussion

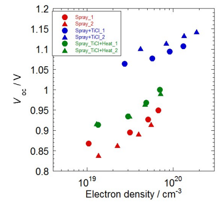

Fig. 1. Relation between V_{oc} and electron density in the compact TiO_2 electrodes

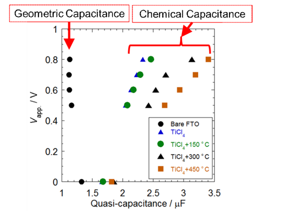

Fig. 2. Relation between V_{oc} and capacitance in the $TiCl_4$ treated FTO-glass electrodes

V_{oc} increased with the $TiCl_4$ treatment at the same electron density and then it decreased after heating.

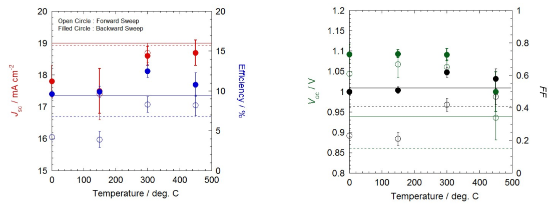

Fig. 3. Relation between heat temperature and *I-V* parameter. Solid line: Reverse sweep, Dashed line: Forward sweep

J_{sc} increased and V_{oc} decreased with the heating temperature after $TiCl_4$ treatment.

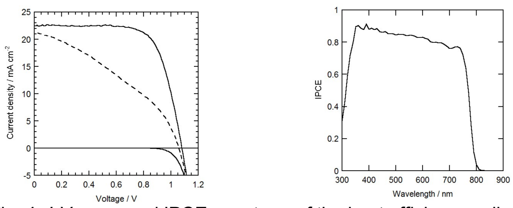

Fig. 4. *I-V* curve and IPCE spectrum of the best efficiency cell

The $TiCl_4$ treated cell subjected to subsequent heating at 300 °C exhibited the best performance, with the power conversion efficiency of the cell being 17% under optimized conditions.

Conclusion

- CBE of the compact TiO_2 layer may change with the $TiCl_4$ treatment and the post-heating.
- The best CBE level for electron transfer in the PSC can be tuned with heating at 300°C after $TiCl_4$ treatment.