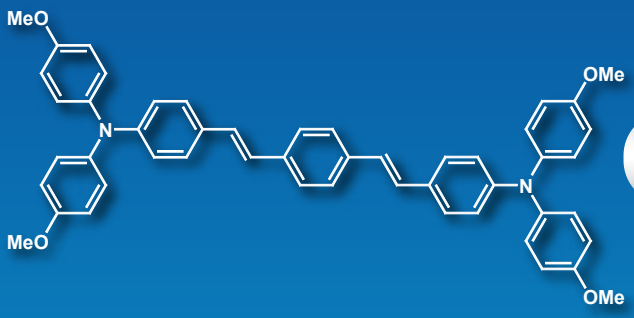
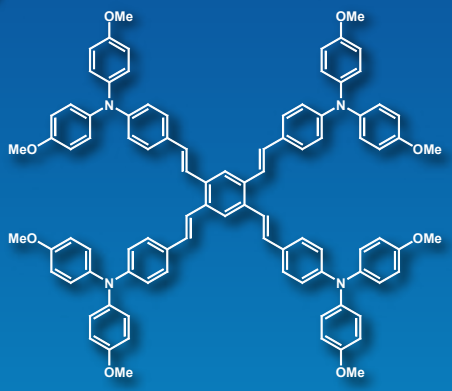
MATERIALS

Hole Transport Materials for Stable Perovskite Solar Cells TOP-HTMs



TCI Original & Practical Hole Transport Materials



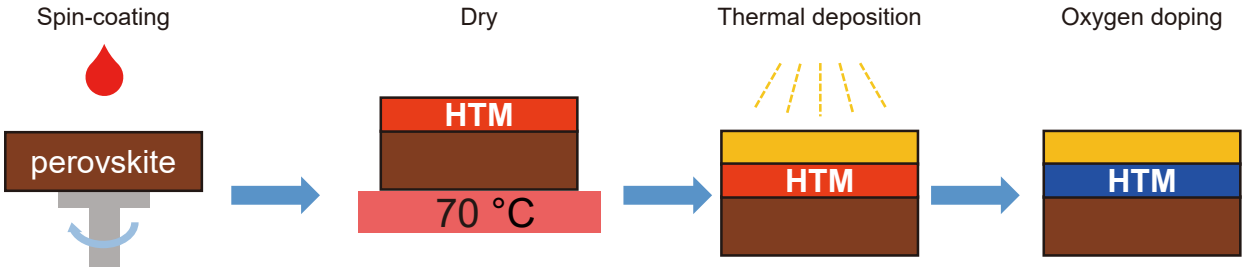
TOP-HTM-α1
1g / 5g / 25g
[B5672]

TOP-HTM-α2
1g / 5g / 25g
[T3722]

Advantages

- **Realizes a high PCE, with or without additives.[1)]**
- **Produces a highly stable perovskite solar cell with low cost.**
- **It is possible to achieve even higher PCE and superior device stability by tuning the compositions of the perovskite layer.[2,3)]**

Device Fabrication Process



1. In a glove box filled with N_2 gas, hole transport layers are deposited on the perovskite layer by spin-coating (slope 5 s, 4000 rpm 30 s, slope 5 s).
2. The resulting film is dried on a hot plate at 70 ˚C for 30 minutes.
3. A metal electrode (Au, etc.) is thermally deposited on the hole transport layer.
4. The solar cell devices are stored in air with ~20% relative humidity to promote oxygen doping.

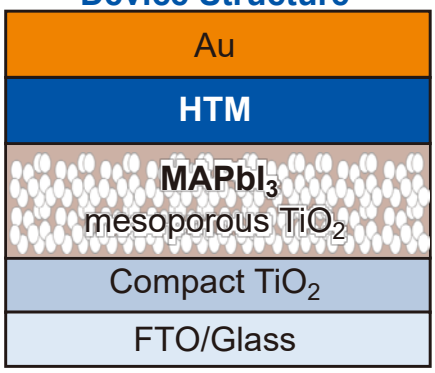
For more details, see the reference 1.

Application: Device performance of $MAPbI_3$-based solar cells [1)]

HTMs are dissolved in solvents at a concentration of 40 mg/mL.

- **With additives**
  Chlorobenzene is used as a solvent. LiTFSI and TBP are added to the HTM solution.
- **Without additives**
  1,1,2,2-Tetrachloroethane is used as a solvent.

Device Structure



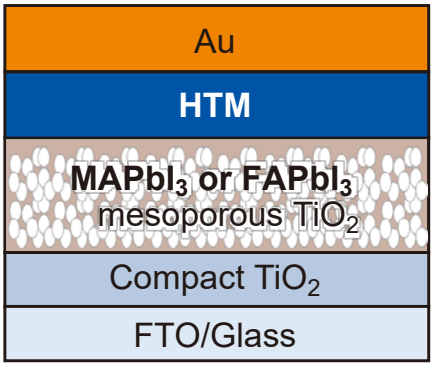
HTM	PCE (%)	Stability (200 h)
TOP-HTM-α1 with additive	13.1	-
TOP-HTM-α1	**15.0**	**0.50**
TOP-HTM-α2 with additive	**18.6**	**0.46**
TOP-HTM-α2	**16.6**	**0.69**
Spiro-OMeTAD with additive	18.4	<0.10
Spiro-OMeTAD	12.1	-

Application: Improvement of perovskite layer [2)]

TOP-HTM-α2 is dissolved in 1,1,2,2-tetrachloroethane without additives.

PCE and device stability of perovskite solar cells using TOP-HTM-α2 are gotten better by changing composition of perovskite layer from $MAPbI_3$ to $FAPbI_3$.

Device Structure



HTM / Perovskite	PCE (%)	Stability (400 h)
TOP-HTM-α2 / $MAPbI_3$	14.31	0.75
TOP-HTM-α2 / $FAPbI_3$	**16.86**	**0.90**
Spiro-OMeTAD with additive / $FAPbI_3$	15.11	0.69
Spiro-OMeTAD / $FAPbI_3$	10.44	0.87

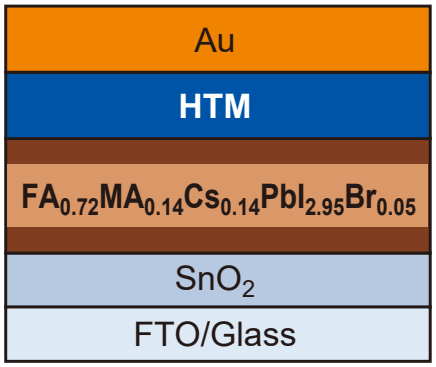
Application: Control of hole transport layer (HTL) morphology [3)]

TOP-HTM-α2 is dissolved in chlorobenzene or dichloromethane. LiTFSI and TBP as additives are added to the solution.

The composition of perovskite layer is $FA_{0.72}MA_{0.14}Cs_{0.14}PbI_{2.95}Br_{0.05}$.

Perovskite solar ce lls using TOP-HT-α2 with additives show superior PCE with improvement of HTL morphology by using dichloromethane instead of chlorobenzene.

Device Structure



HTM	Solvent	PCE (%)
TOP-HTM-α2 with additive	Chlorobenzene	18.67
TOP-HTM-α2 with additive	**Dichloromethane**	**20.18**
Spiro-OMeTAD with additive	Chlorobenzene	18.85
Spiro-OMeTAD with additive	Dichloromethane	18.55

References

1) Additive-free, Cost-Effective Hole-Transporting Materials for Perovskite Solar Cells Based on Vinyl Triarylamines
H. Nishimura, I. Okada, T. Tanabe, T. Nakamura, R. Murdey, A. Wakamiya, *ACS Appl. Mater. Interfaces* **2020**, *12*, 32994. https://doi.org/10.1021/acsami.0c06055

2) Experimental investigation of additive free-low-cost vinyl triarylamines based hole transport material for $FAPbI_3$-based perovskite solar cells to enhance efficiency and stability
A. Kumar, S. Singh, M. K A Mohammed, D. S Ahmed, *Mater. Res. Express* **2023**, *10*, 044003. https://doi.org/10.1088/2053-1591/accd41

3) An Alternative to Chlorobenzene as a Hole Transport Materials Solvent for High-Performance Perovskite Solar Cells
S. H. Lee, S. B. Lim, J. Y. Kim,S. Lee, S. Y. O, M. Kim, *Crystals* **2023**, *13*, 1667. https://doi.org/10.3390/cryst13121667

Hole Transport Materials for Stable Perovskite Solar Cells: TOP-HTMs

Related Products

Formamidine Hydroiodide (= FAI) (99.99%, trace metals basis) [for Perovskite precursor]	1g / 5g / 25g [F1263]
Methylamine Hydroiodide (= MAI) (Low water content)	1g / 5g / 25g / 100g [M2556]
Spiro-OMeTAD	1g / 5g [T3672]
Lithium Bis(trifluoromethanesulfonyl)imide (= LiTFSI)	25g / 250g [B2542]
4-*tert*-Butylpyridine	5g / 25g [B0388]
Lead(II) Iodide (99.99%, trace metals basis) [for Perovskite precursor]	1g / 5g / 25g / 100g / 1kg [L0279]
Lead(II) Bromide [for Perovskite precursor]	1g / 5g / 25g [L0288]
Lead(II) Chloride (purified by sublimation) [for Perovskite precursor]	1g / 5g [L0291]
Lead(II) Chloride [for Perovskite precursor]	1g / 5g / 25g [L0292]

For further information please refer to our website at www.TCIchemicals.com. ▶▶▶ TCI perovskite

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