

Supporting Information

A-D-A-type S,N-Heteropentacene-based Hole Transport Materials for Dopant-free Perovskite Solar Cells

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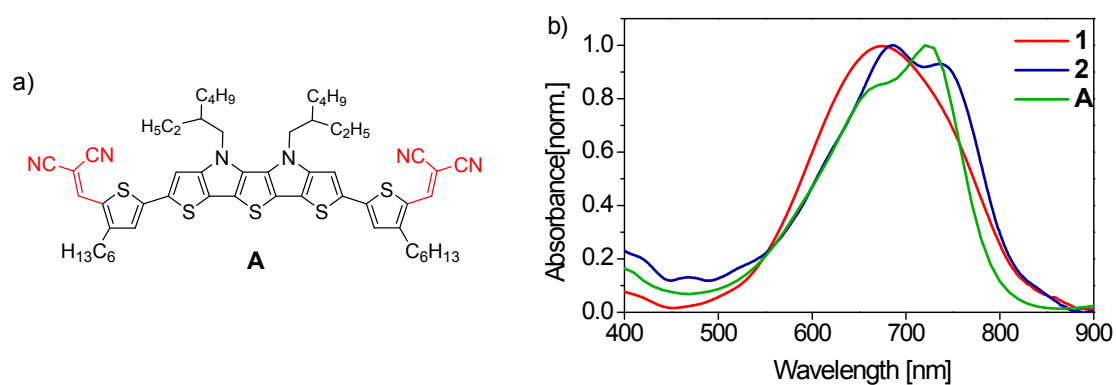


Figure S1. a) Chemical structure oligomer **A** and b) UV-Vis absorption spectra of HTMs **1** and **2** on TiO₂ film compared with oligomer **A** reported in *reference 1*.

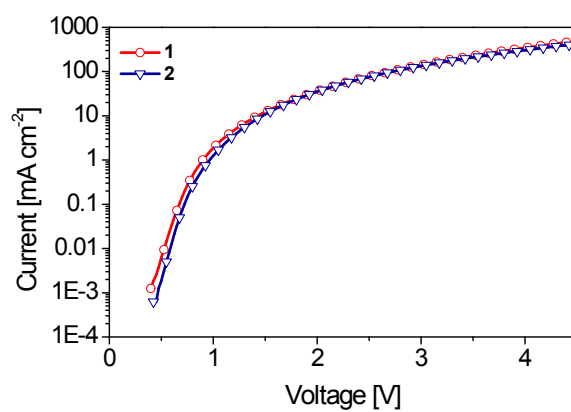


Figure S2. *J-V* plots of the hole-only devices for oligomers **1** and **2**.

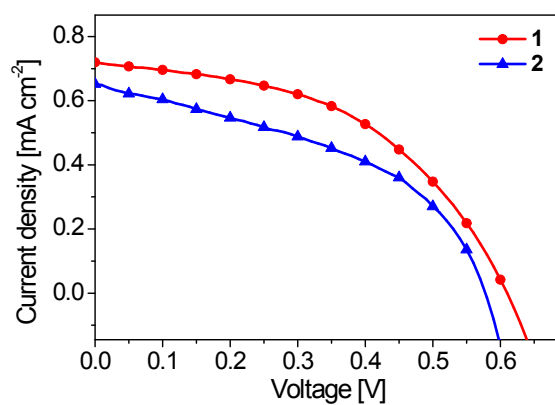


Figure S3. The *J-V* characteristics of the heterojunction solar cells based on the device configuration of TiO₂/HTM **1** or **2**/Au.

Table S1. Photovoltaic parameters of CH₃NH₃PbI₃-based solar cells with HTMs **1** and **2** using different concentration and spin speed.

HTM	Conc. [M]/ Spin speed [rpm]	J_{sc} [mA cm ⁻²]	V_{oc} [mV]	FF	PCE [%]
1	0.04/4000	16.6	950	0.68	10.7
1	0.04/2000	16.7	948	0.66	10.4
1	0.03/2000	16.6	953	0.72	11.4
1	0.03/2000	16.5	955	0.71	11.2
1	0.03/2000	16.5	956	0.72	11.3
1	0.03/2000	16.6	951	0.72	11.4
1	0.03/4000	16.3	942	0.71	10.9
1	0.02/2000	16.0	938	0.70	10.5
1	0.02/4000	15.8	923	0.69	10.1
2	0.04/4000	15.9	899	0.67	9.6
2	0.04/2000	16.2	884	0.66	9.5
2	0.03/2000	16.3	899	0.70	10.3
2	0.03/2000	16.2	896	0.70	10.1
2	0.03/2000	16.2	886	0.70	10.0
2	0.03/2000	15.9	904	0.71	10.2
2	0.03/4000	14.6	913	0.72	9.6
2	0.02/2000	13.8	907	0.67	8.4
2	0.02/4000	13.3	891	0.70	8.3

Table S2. Photovoltaic parameters of solar cells with configuration of TiO₂/HTM **1** or **2**/Au without the perovskite layer.

HTM	J_{sc} [mA cm ⁻²]	V_{oc} [mV]	FF	PCE [%]
1	0.72	0.64	0.48	0.22
2	0.65	0.60	0.44	0.17

Reference

1. P. Qin, H. Kast, M. K. Nazeeruddin, S. M. Zakeeruddin, A. Mishra, P. Bauerle and M. Gratzel, *Energy Environ. Sci.*, 2014, **7**, 2981-2985.