Supporting Information

Fluorinated Benzoselenadiazole-based Low-Band–Gap Polymers for High Efficiency Inverted Single and Tandem Organic Photovoltaic Cells

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Figure S1. (a) TGA plot of polymers with a heating rate of 10 °C/min under nitrogen. (b) DSC thermograms of polymers under nitrogen (cooling rate: 10 °C/min).

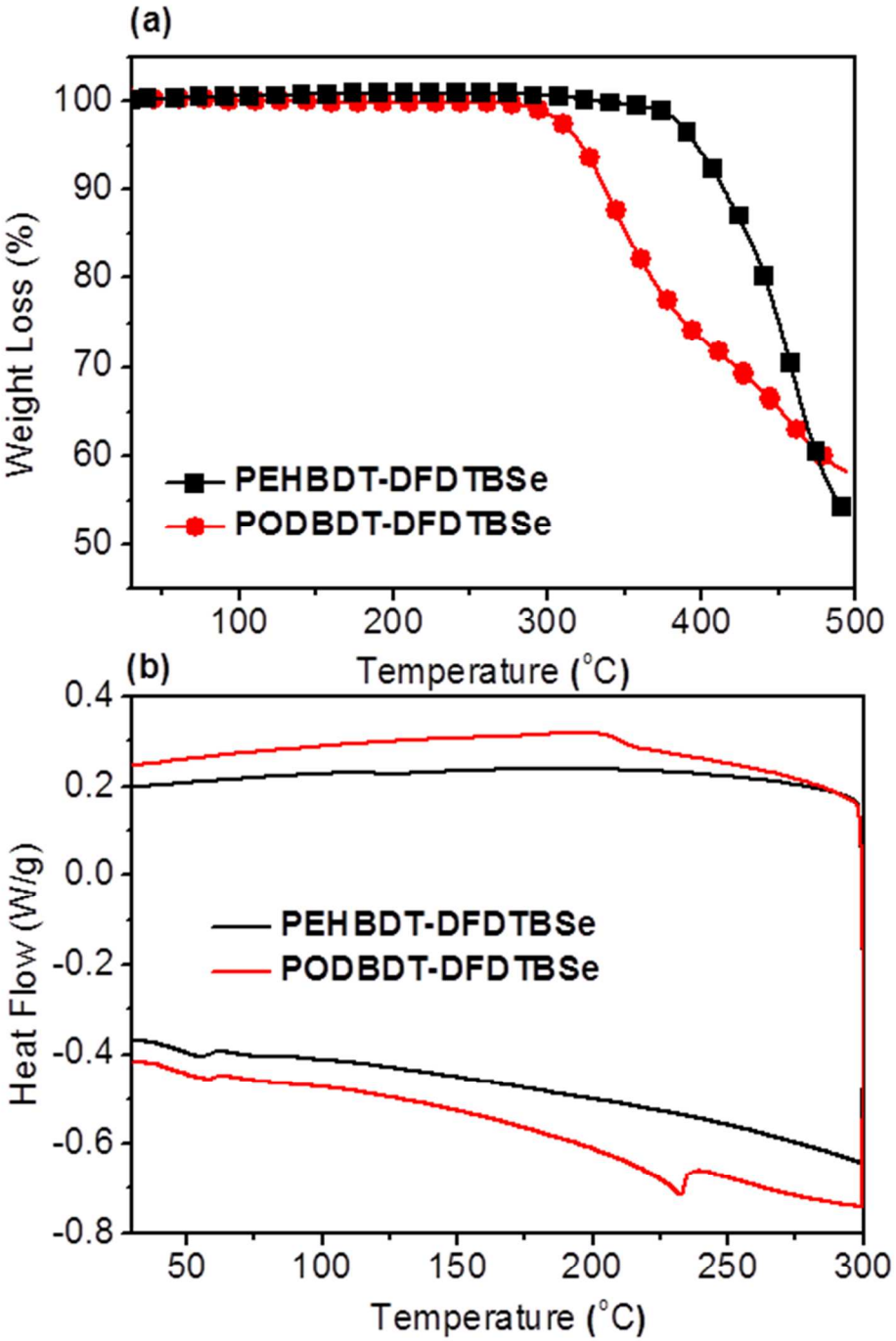

Figure S2. Cyclic voltammograms of polymer films on a platinum electrode in 0.10 M $TBABF_4$ acetonitrile solution. (a) Polymers and (b) $PC_{71}BM$, respectively.

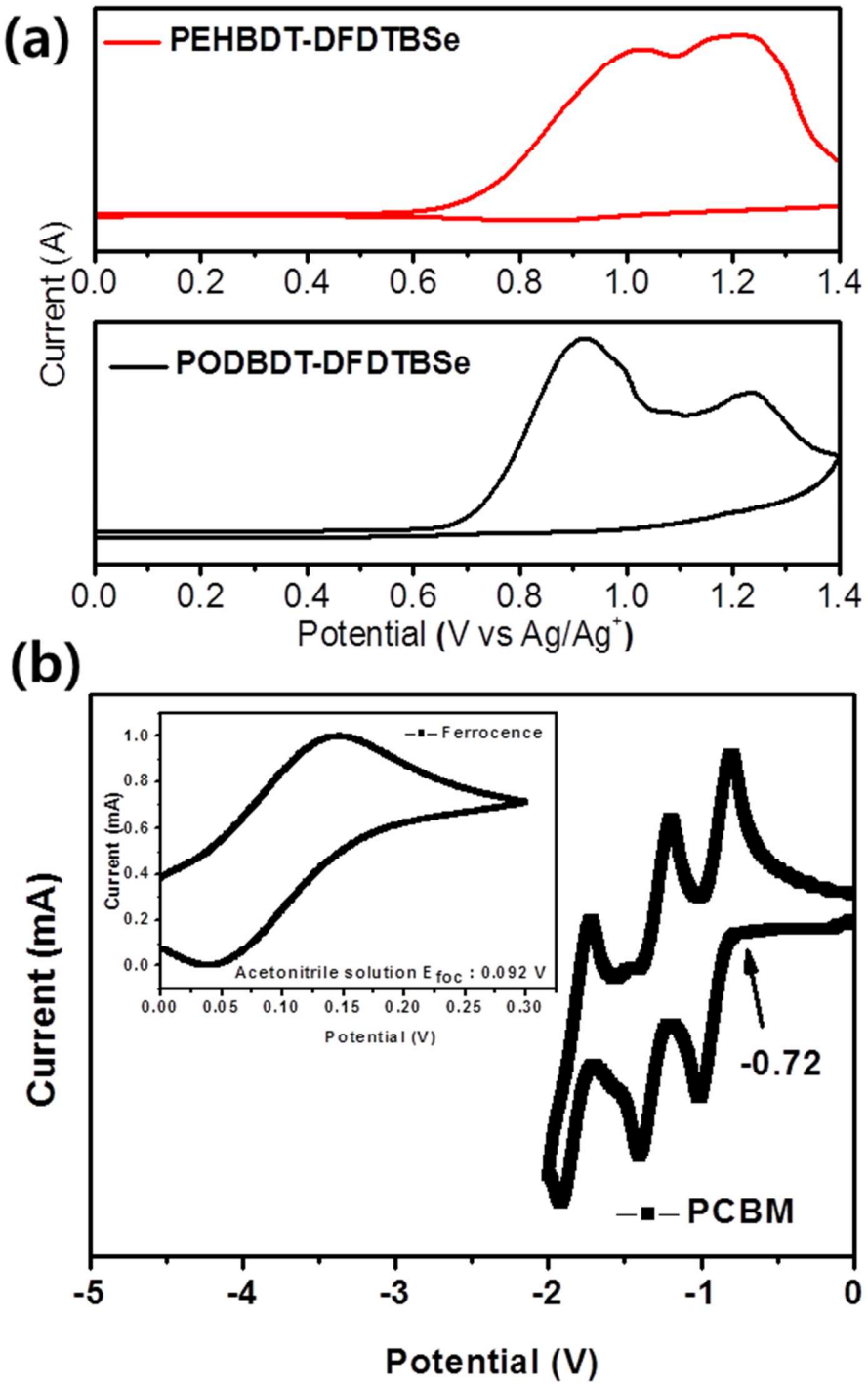

Figure S3. (a) *J–V* curves for a device with ITO/PEDOT:PSS/PEHBDT-DFDTBSe:$PC_{71}BM$/Ca/Al configuration with different weight ratios. (b) EQE curves of the OPVs based on PEHBDT-DFDTBSe:$PC_{71}BM$ with different weight ratios.

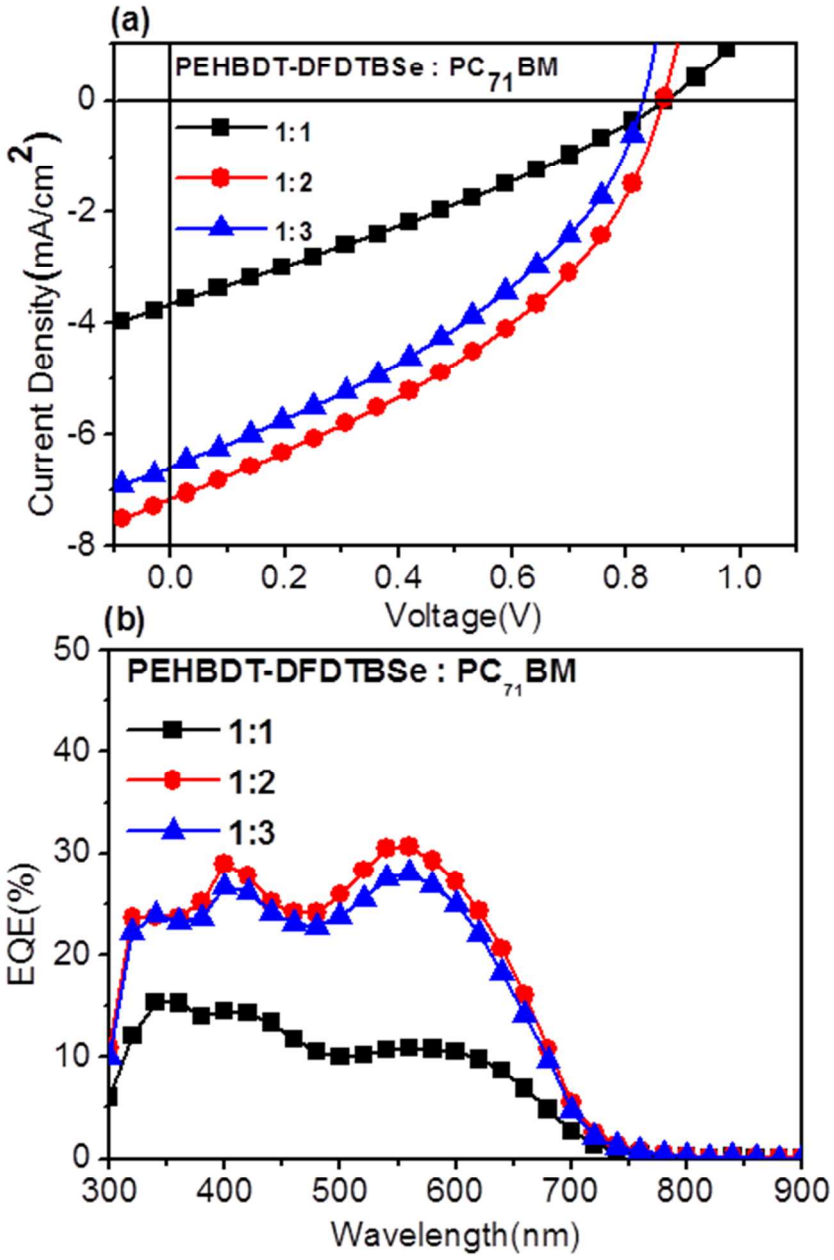

Table S1. Comparison of the photovoltaic properties of the OPVs based on PEHBDT-DFDTBSe:$PC_{71}BM$ with different weight ratios measured under AM 1.5G illumination (100 mW/cm²).

Active layer [Solvent]	Ratio	V_{oc} [V]	J_{sc} [mA/cm²]	*FF*	*PCE* [%]	R_{sh} (Ω·cm²)	R_s (Ω·cm²)
PEHBDT-DFDTBSe: $PC_{71}BM$ [CB]	1 : 1	0.87	3.65	0.29	0.93	289.48	144.53
	1 : 2	0.87	7.16	0.39	2.41	228.95	36.78
	1 : 3	0.83	6.57	0.38	2.05	230.33	34.96

Figure S4. (a) *J*–*V* curves for ITO/PEDOT:PSS/PEHBDT-DFDTBSe:$PC_{71}BM$ (1:2 w/w, processed with 3 vol% DIO)/Ca/Al configuration after annealing at different temperatures for 10 min. (b) EQE curves of OPVs based on PEHBDT-DFDTBSe:$PC_{71}BM$ annealed at different temperatures. (c) *J*–*V* characteristics of PEHBDT-DFDTBSe:$PC_{71}BM$ (1:2 w/w, with DIO) in regular single-junction OPVs in the dark.

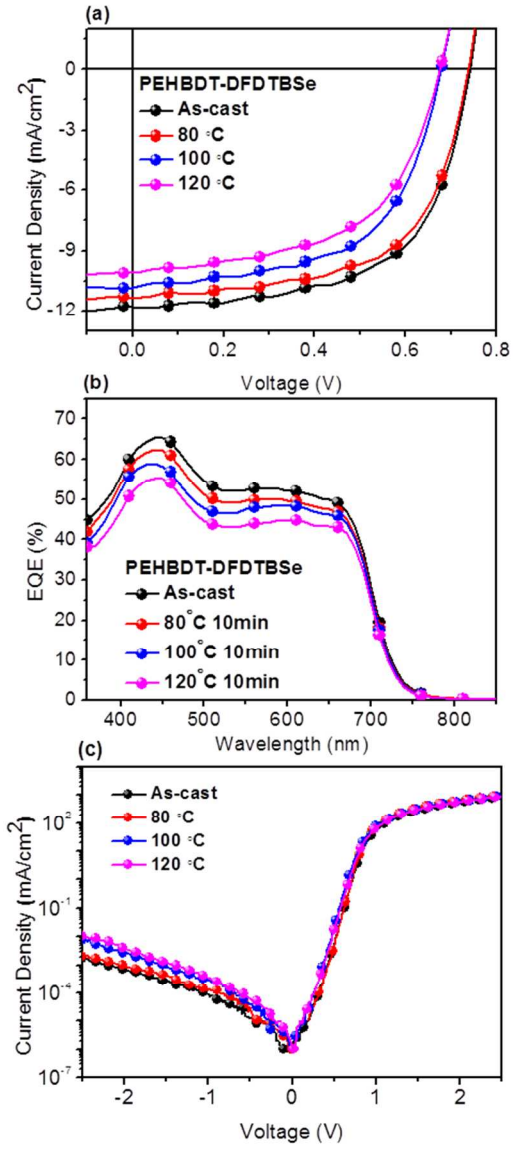

Table S2. Comparison of the photovoltaic properties of the OPVs based on PEHBDT-DFDTBSe:$PC_{71}BM$ (1:2 w/w, processed with 3 vol% DIO) annealed at different temperatures under AM 1.5G illumination (100 mW/cm^2).

Polymer	Annealing [10 min]	V_{oc} [V][a]	J_{sc} [mA/cm^2][a]	*FF*[a]	PCE [%][a]
PEHBDT-DFDTBSe: $PC_{71}BM$ with DIO (1:2, w/w)	W/O	0.74	11.79	0.61	5.30
	80 °C	0.74	11.36	0.60	5.07
	100 °C	0.68	10.81	0.58	4.25
	120 °C	0.68	10.11	0.55	3.79

[a)]The devices architecture is ITO/PEIE/Active layer(~90 nm)/MoO_3/Ag

Figure S5. ^{1}H NMR of 2,6-bis(trimethyltin)-4,8-diethylhexyloxybenzo-[1,2-b;3,4-b]dithiophene.

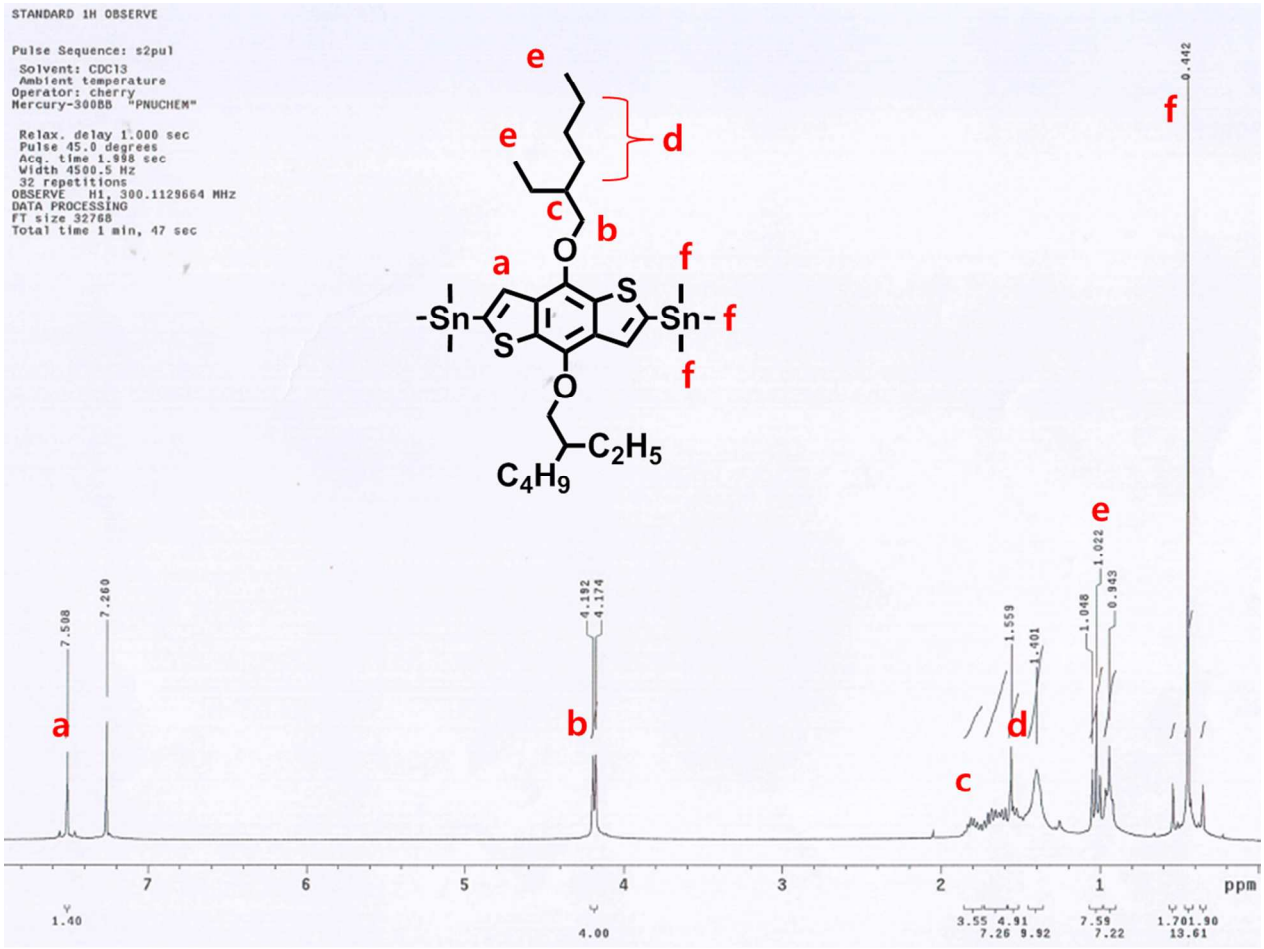

Figure S6. ^{1}H NMR of 2,6-bis(trimethyltin)-4,8-dioctyldodecyloxybenzo-[1,2-b;3,4-b]dithiophene.

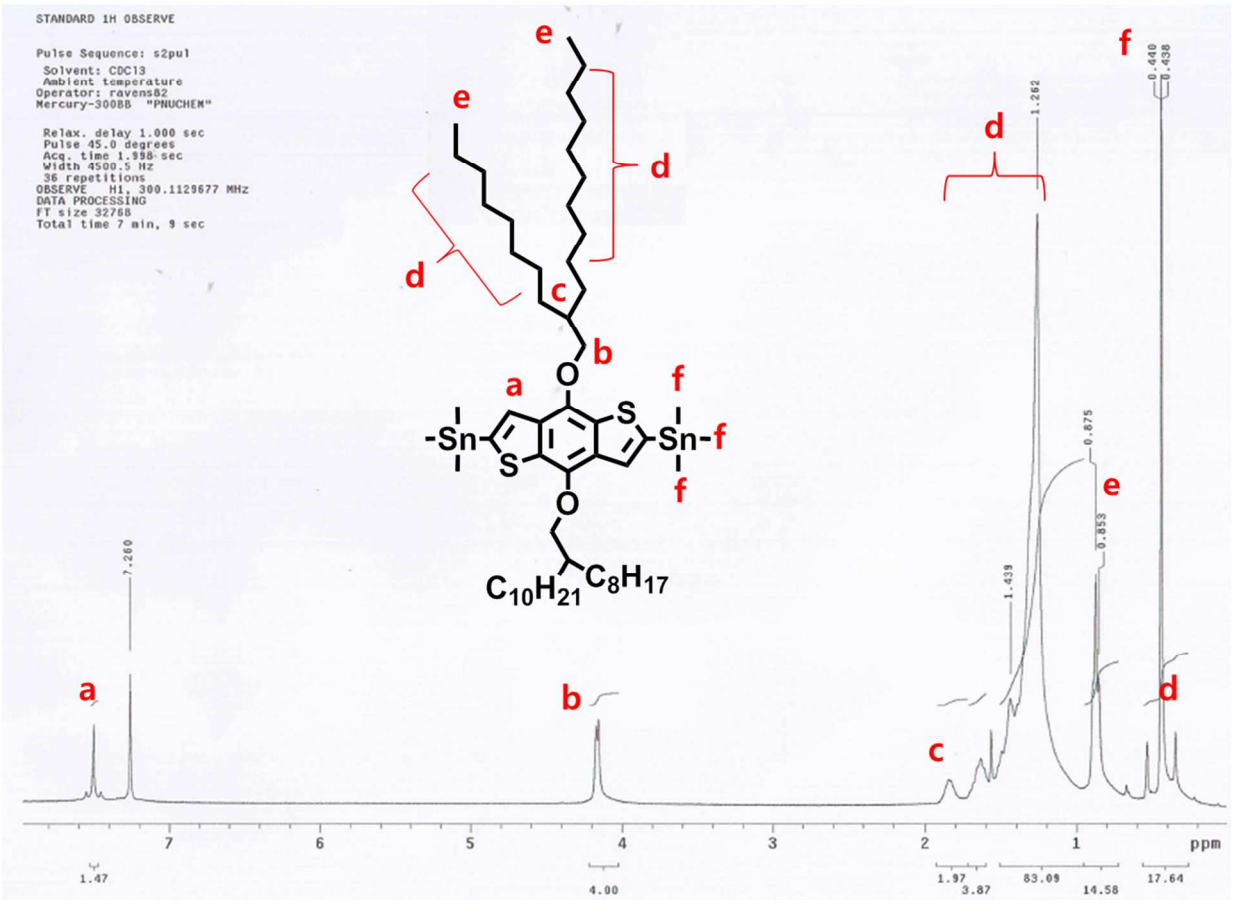

Figure S7. (a) ^{1}H NMR and (b) ^{19}F-NMR spectrum of 4,7-dibromo-5,6-difluoro-[2,1,3]benzoselenadiazole (1).

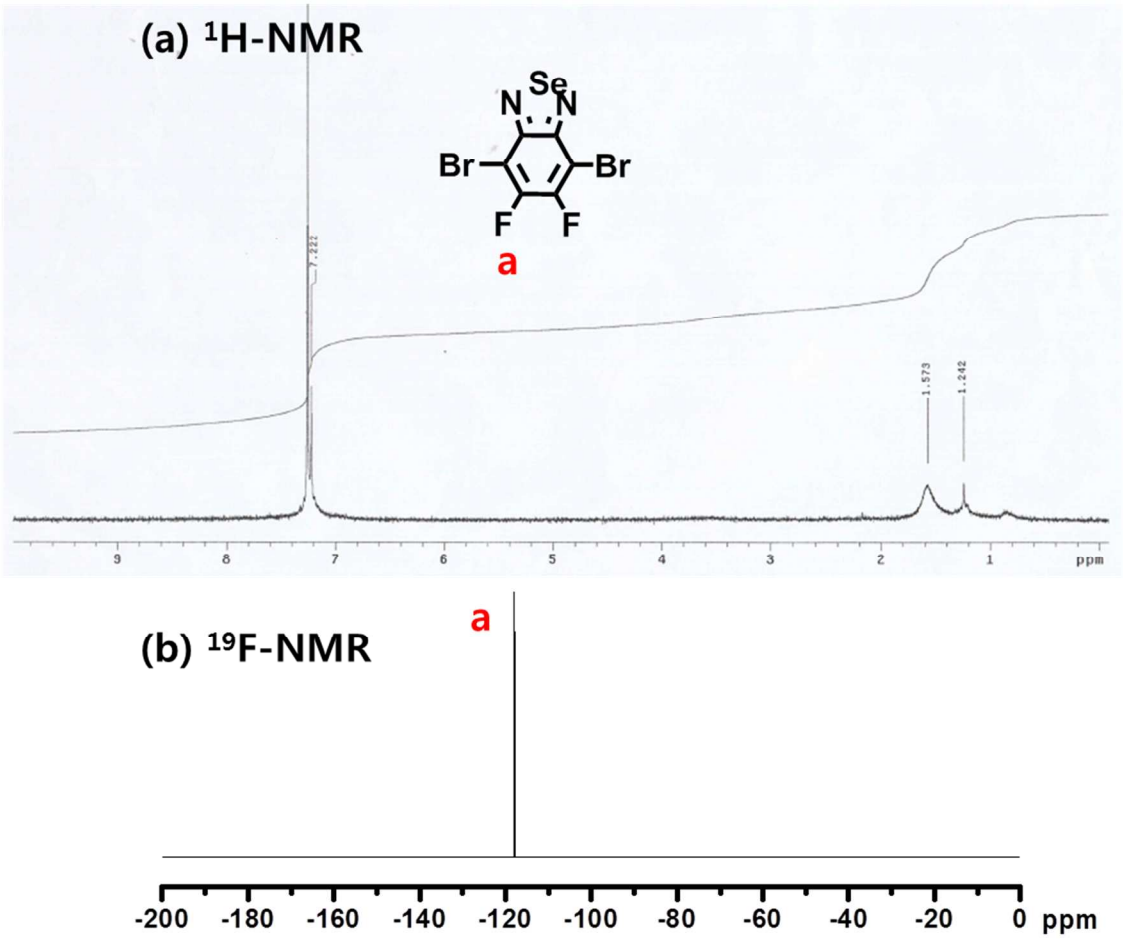

Figure S8. ^{1}H NMR spectrum of 5,6-difluoro-4,7-bis(4-(2-ethylhexyl)-2-thienyl)-2,1,3-benzoselenadiazole (**2**).

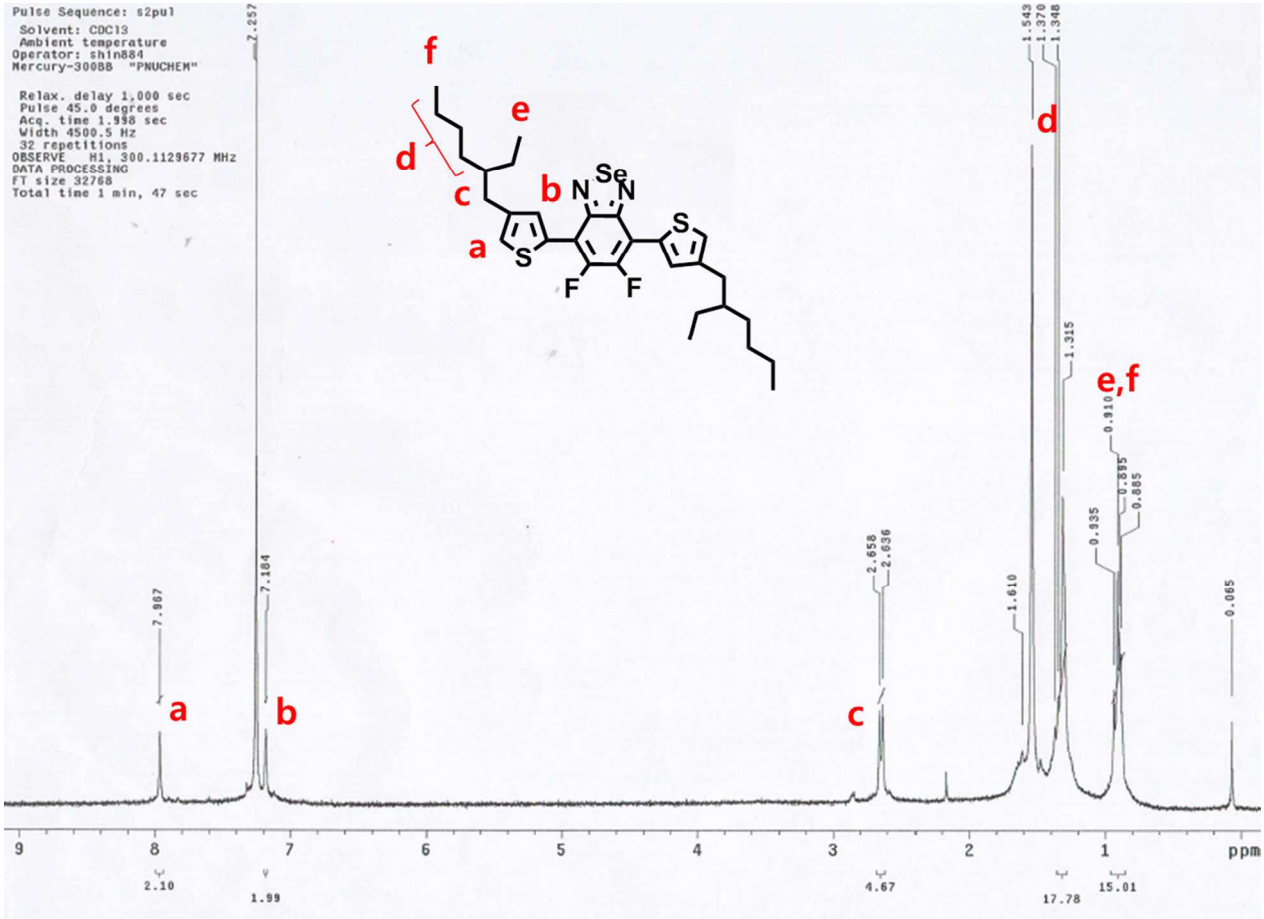

Figure S9. ^{1}H NMR spectrum of 4,7-bis(5-bromo-4-(2-ethylhexyl)-2-thienyl)-5,6-difluoro-2,1,3-benzoselenadiazole (DFDTBSe).

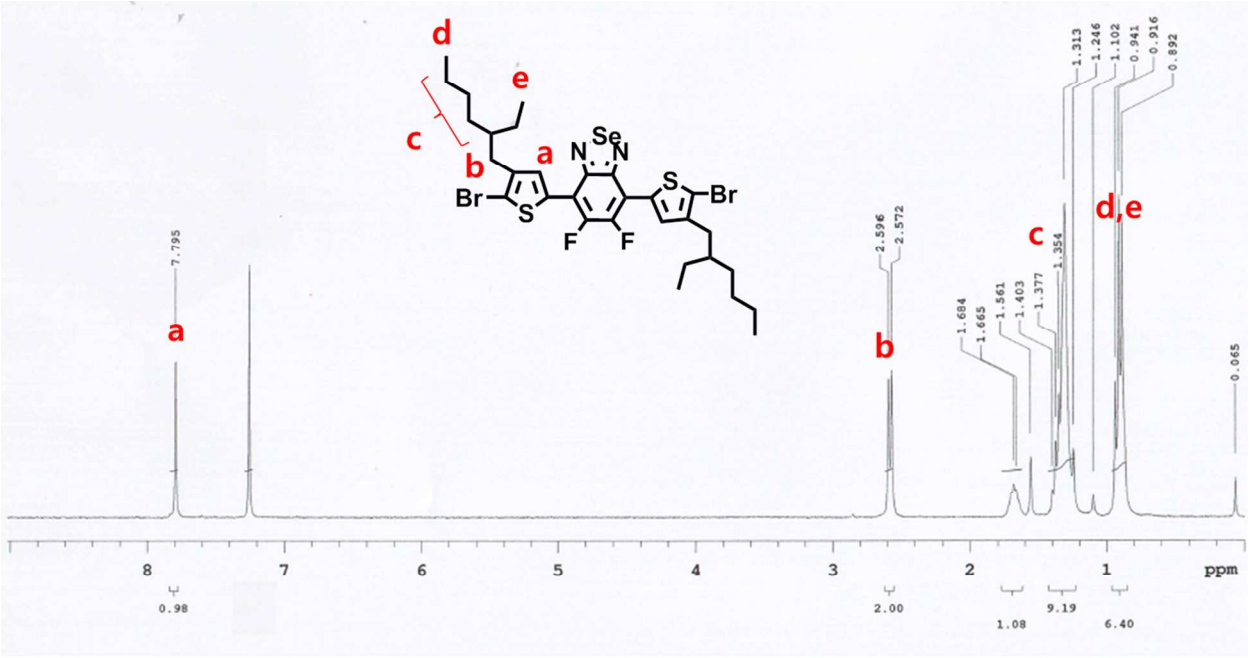

Figure S10. ^{1}H NMR spectrum of PEHBDT-DFDTBSe.

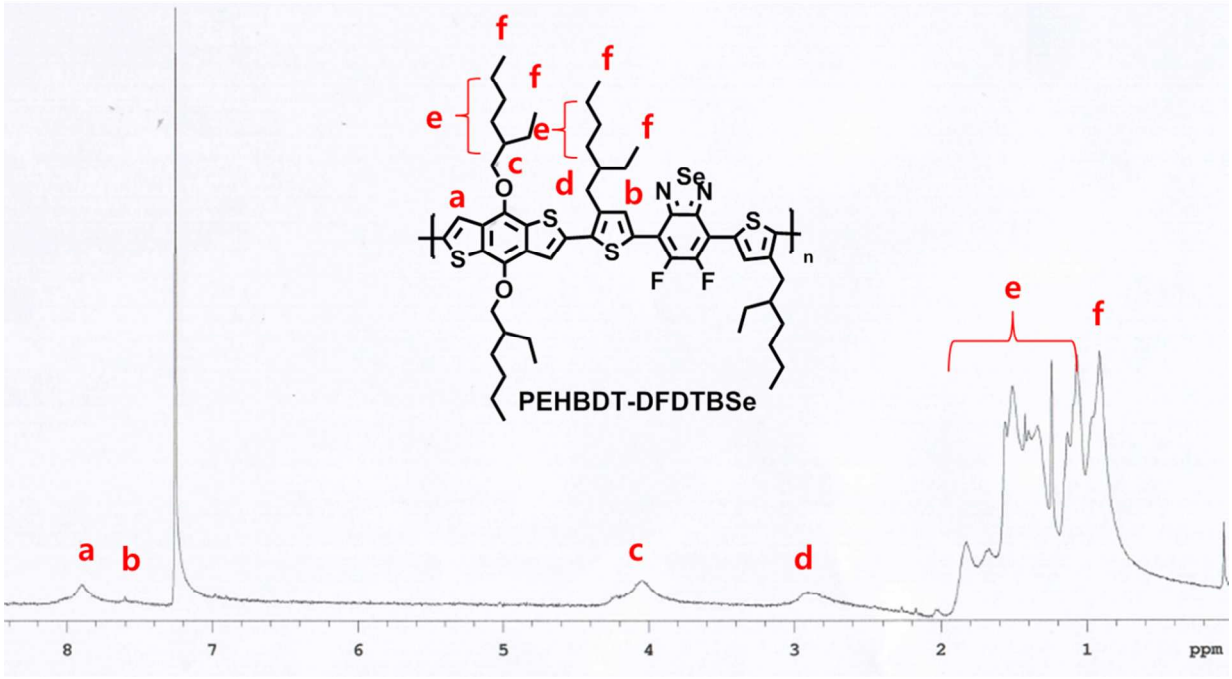

Figure S11. ^{1}H NMR spectrum of PODBDT-DFDTBSe.