Electronic Supplementary Material (ESI) for Polymer Chemistry.

Supplementary information

Fabrication of Multi-responsive Photonic Crystals based on Selenium-containing Copolymers

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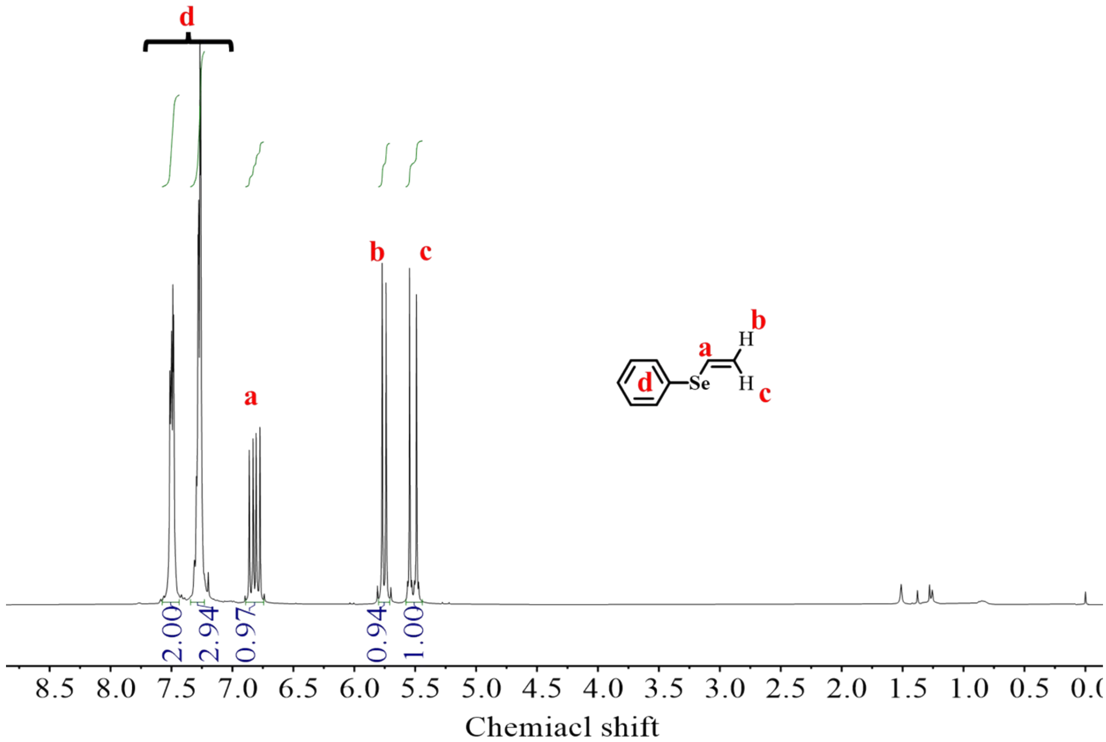


Figure S1. ^{1}H NMR spectrum of PVSe.

Table S1. Radical copolymerization of PVSe with 4VP in different molar ratio in bulk at 60 °C for 16 h.

Entry	$[PVSe]_0$/ $[4VP]_0$/ $[AIBN]_0$	[a] Yield(%)	[b] $M_{n,\ th.}$ [g mol^{-1}]	[c] $M_{n,\ SEC}$ [g mol^{-1}]	[c] $Đ$	[d] F_{PVSe}
1	$[PVSe]_0$/ $[4VP]_0$/ $[AIBN]_0$=10/90/1	98.9	27500	338000	1.70	0.042
2	$[PVSe]_0$/ $[4VP]_0$/ $[AIBN]_0$=30/70/1	92.4	11800	128000	1.79	0.167
3	$[PVSe]_0$/ $[4VP]_0$/ $[AIBN]_0$=50/50/1	50.8	7300	21700	3.19	0.285
4	$[PVSe]_0$/ $[4VP]_0$/ $[AIBN]_0$=70/30/1	65.0	15800	13000	3.03	0.354
5	$[PVSe]_0$/ $[4VP]_0$/ $[AIBN]_0$=80/20/1	49.1	8200	5500	2.30	0.498
6	$[PVSe]_0$/ $[4VP]_0$/ $[AIBN]_0$=90/10/1	40.3	7000	5100	1.84	0.623

[a] n-hexane-insoluble part.

[b] The theoretical molecular weight ($M_{n,\ th.}$ = [(M_W of PVSe) ×f_{PVSe}+ (M_W of 4VP) ×f_{4vp}] × Yield. + (M_W of CTA).

[c] Measured by size-exclusion chromatography (SEC) using polystyrene standards in DMF (10 mM LiBr).

[d] Determined by ^{1}H NMR in DMSO-d_6, ignoring the influence of end groups:

$$F_{PVSe} = \frac{I(6.15-7.73)-I(7.99-8.59)}{5} \div \left(\frac{I(6.15-7.73)-I(7.99-8.5}{5}\right)$$

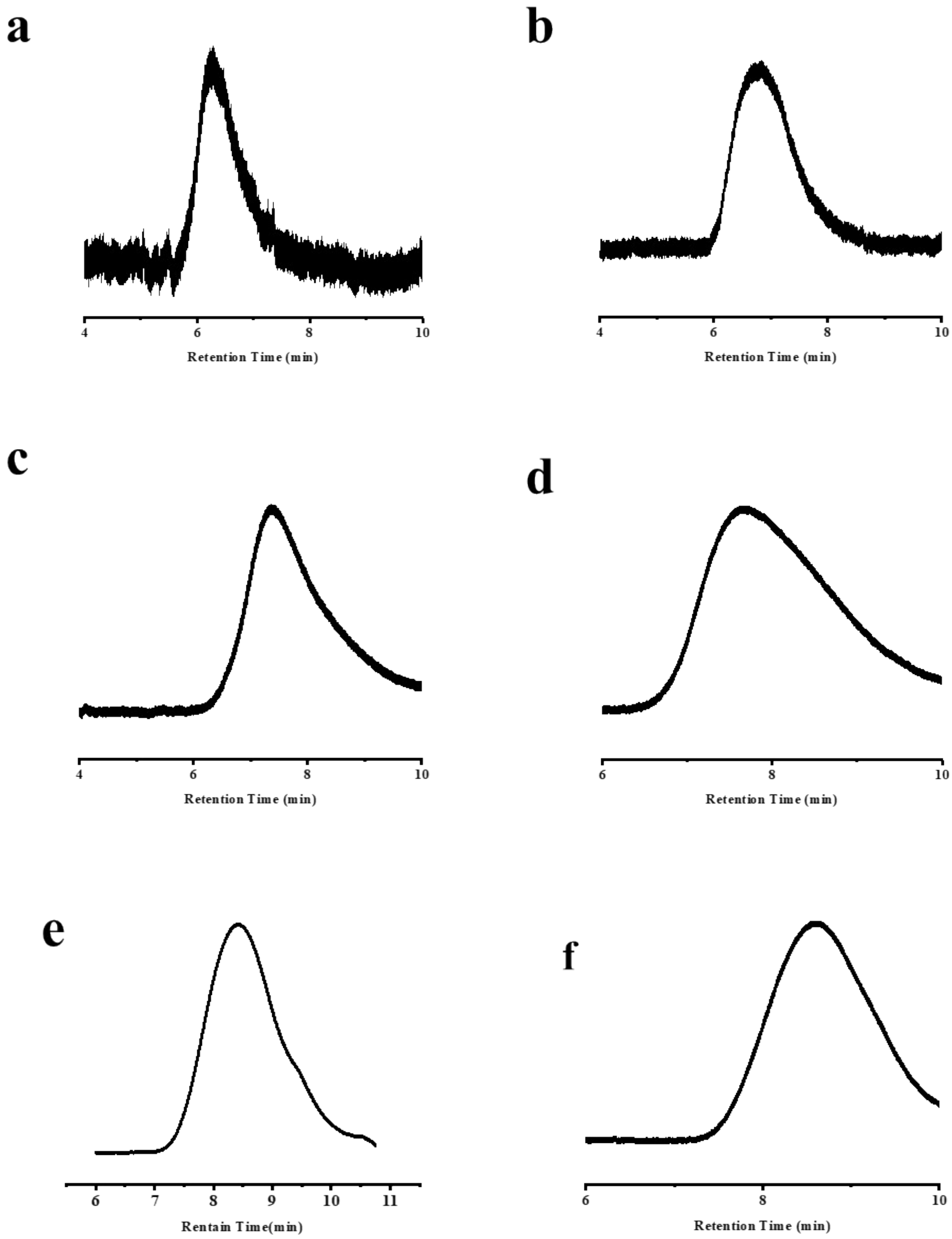


Figure S2. a) SEC traces of Entry 1 in Table S1 using polystyrene (PS) as standard in DMF (0.01M LiBr); b) SEC traces of Entry 2 in Table S1 using polystyrene (PS) as standard in DMF (0.01M LiBr); c) SEC traces of Entry 3 in Table S1 using polystyrene (PS) as standard in DMF (0.01M LiBr); d) SEC traces of Entry 4 in Table S1 using polystyrene (PS) as standard in DMF (0.01M LiBr); e) SEC traces of Entry 5 in Table S1 using polystyrene (PS) as standard in DMF (0.01M LiBr); f) SEC traces of Entry 6 in Table S1 using polystyrene (PS) as standard in DMF (0.01M LiBr).

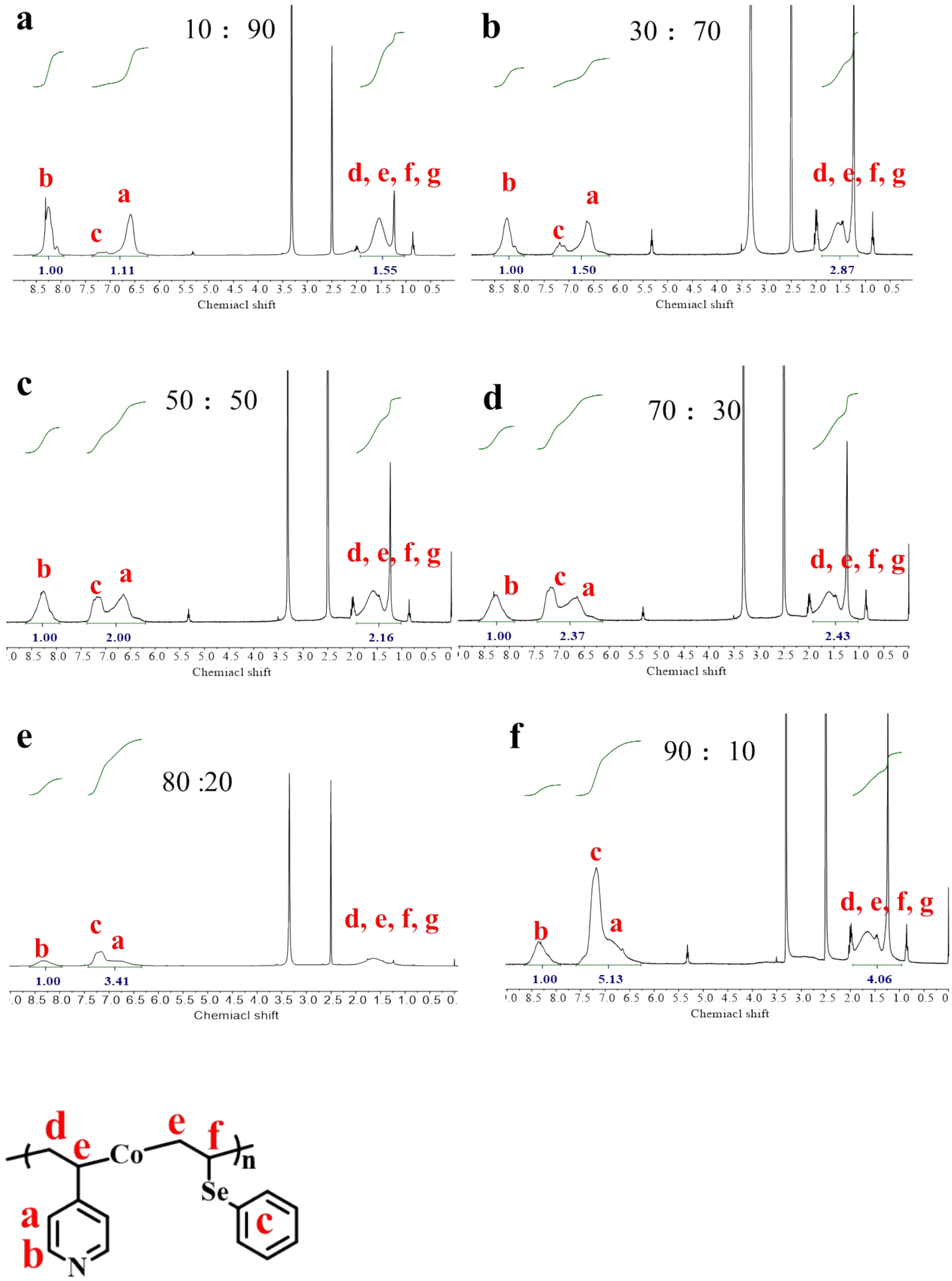


Figure S3. a) ^{1}H NMR spectrum of Entry 1 in Table S1; b) ^{1}H NMR spectrum of Entry 2 in Table S1; c) ^{1}H NMR spectrum of Entry 3 in Table S1; d) ^{1}H NMR spectrum of Entry 4 in Table S1; e) ^{1}H NMR spectrum of Entry 5 in Table S1. f) ^{1}H NMR spectrum of Entry 6 in Table S1

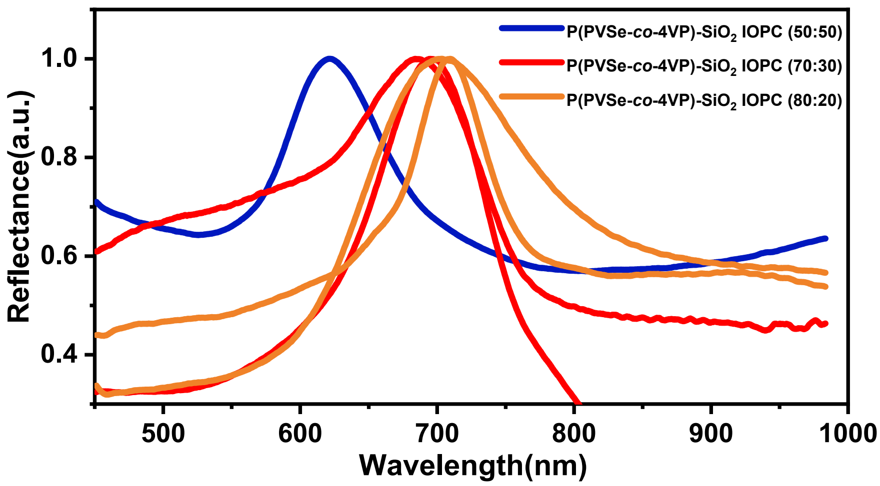


Figure S4. The normalized reflectance spectrum of the P(PVSe-*co*-4VP)-SiO_2 IOPC (50:50), P(PVSe-*co*-4VP)-SiO_2 IOPC (70: 30), P(PVSe-*co*-4VP)-SiO_2 IOPC (80:20) (the specific value following P(PVSe-*co*-4VP) SiO_2 IOPC is the molar ratio of PVSe and 4VP and P(PVSe-*co*-4VP)-SiO_2 IOPC (50:50) is Entry 3 in Table S1, P(PVSe-*co*-4VP)-SiO_2 IOPC (70:30) is Entry 4 in Table S1, P(PVSe-*co*-4VP)-SiO_2 IOPC (80:20) is Entry 5 in Table S1).

Table S2. RAFT copolymerization of PVSe with 4VP at 60 °C for 30 h using BPCD as CTA at different molar ratio of $[PVSe]_0/[4VP]_0/[CTA]_0$ in bulk ($[CTA]_0/[AIBN]$=1/0.5).

Entry	$[PVSe]_0/[4VP]_0$	$[M]_0/[CTA]_0$	[a]yield (%)	[b]$M_{n,SEC}$ [g mol^{-1}]	[b] $Đ$	[c]F_{PVSe}	n_{589}
1	$[PVSe]_0/[4VP]_0$ = 70/30	$[M]_0/[CTA]_0$= 100/1	36.6	2400	1.24	0.389	1.636
2	$[PVSe]_0/[4VP]_0$ =80/20	$[M]_0/[CTA]_0$= 100/1	31.6	2300	1.19	0.510	1.642
3		$[M]_0/[CTA]_0$= 200/1	21.5	3600	1.36	0.523	1.643
4		$[M]_0/[CTA]_0$= 400/1	15.4	3900	1.31	0.451	1.648
5	$[PVSe]_0/[4VP]_0$ =90/10	$[M]_0/[CTA]_0$= 100/1	11.5	1900	1.15	0.525	1.650
6		$[M]_0/[CTA]_0$= 200/1	6.0	1900	1.13	0.587	1.656
7		$[M]_0/[CTA]_0$= 400/1	3.7	2500	1.21	0.569	1.650

[a] n-hexane-insoluble part.

[b] Measured by size-exclusion chromatography (SEC) using polystyrene standards in DMF (10 mM LiBr).

[c] Determined by ^1H NMR in DMSO-d_6, ignoring the influence of end groups:

$$F_{PVSe} = \frac{I(6.15-7.73)-I(7.99-8.59)}{5} \div \left(\frac{I(6.15-7.73)-I(7.99-8.5}{5}\right)$$

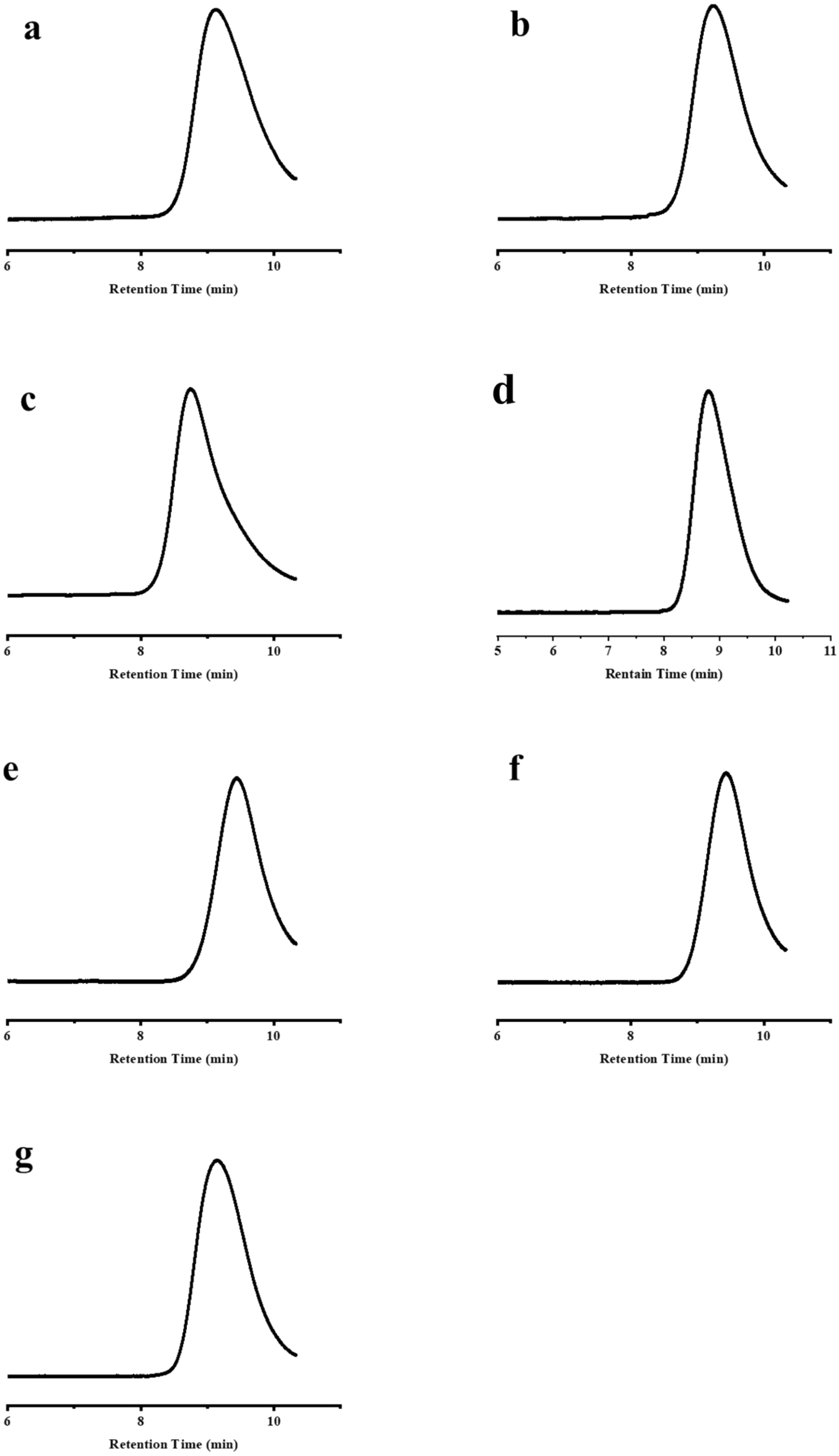


Figure S5. a) SEC trace of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0/[CTA]_0$/ $[AIBN]_0$=70/30/1/0.5; b) SEC trace of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0/[CTA]_0$/ $[AIBN]_0$=80/20/1/0.5; c) SEC trace of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0/[CTA]_0$/ $[AIBN]_0$=160/400/1/0.5; d) SEC trace of

P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0$/$[CTA]_0$/ $[AIBN]_0$=320/80/1/0.5; e) SEC trace of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0$/$[CTA]_0$/ $[AIBN]_0$=90/10/1/0.5; f) SEC trace of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0$/$[CTA]_0$/ $[AIBN]_0$=180/20/1/0.5; g) SEC trace of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0$/$[CTA]_0$/ $[AIBN]_0$=360/40/1**/**0.5.

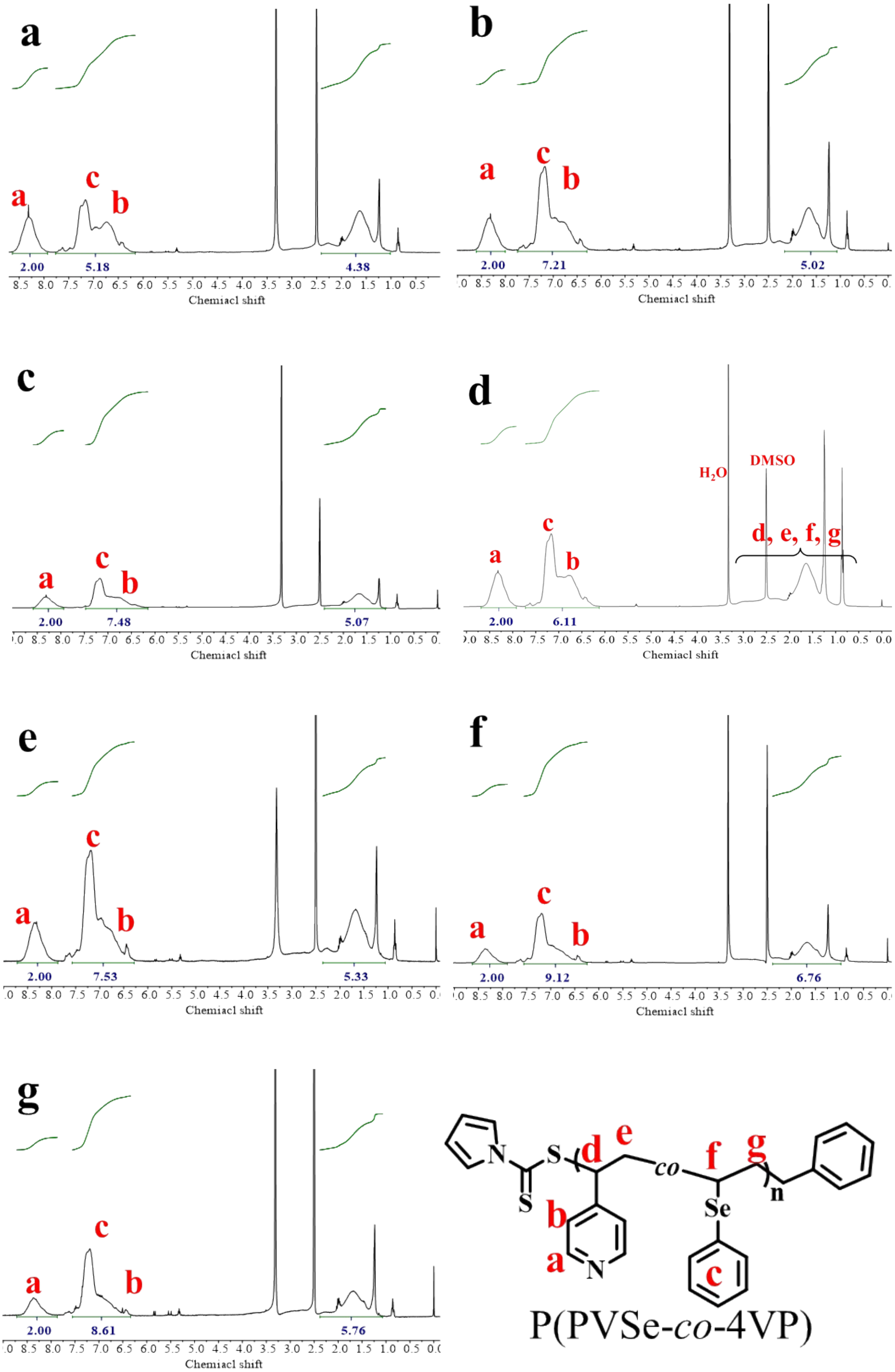


Figure S6. a) ^{1}H NMR spectrum of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0/[CTA]_0$/ $[AIBN]_0$=70/30/1/0.5; b) ^{1}H NMR spectrum of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0/[CTA]_0$/ $[AIBN]_0$=80/20/1/0.5; c) ^{1}H NMR spectrum of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0/[CTA]_0$/

$[AIBN]_0$=160/400/1/0.5; d) ^{1}H NMR spectrum of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0$/$[CTA]_0$/ $[AIBN]_0$=320/80/1/0.5; e) SEC trace of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0$/$[CTA]_0$/ $[AIBN]_0$=90/10/1/0.5; f) ^{1}H NMR spectrum of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0$/$[CTA]_0$/ $[AIBN]_0$=180/20/1/0.5; g) ^{1}H NMR spectrum of P(PVSe-*co*-4VP) with the molar ratio of $[PVSe]_0$/ $[4VP]_0$/$[CTA]_0$/ $[AIBN]_0$=360/40/1/0.5.

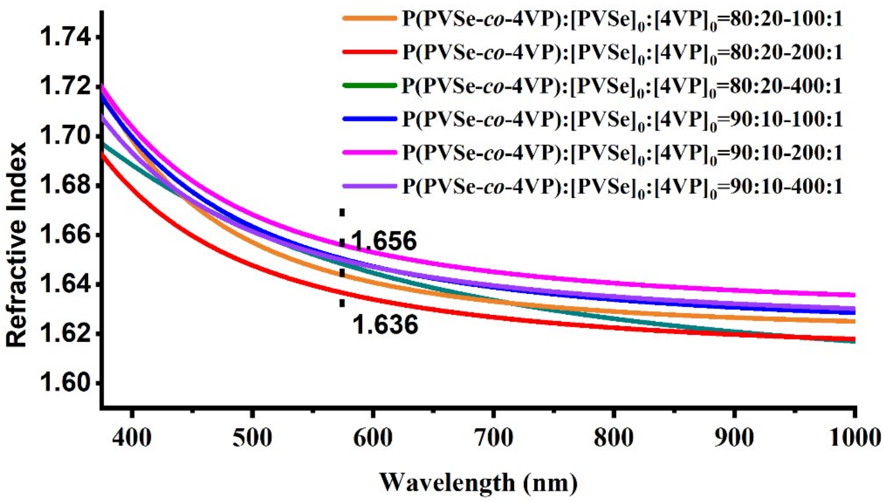


Figure S7. Refractive index curves of P(PVSe-*co*-4VP) using different molar ratio.

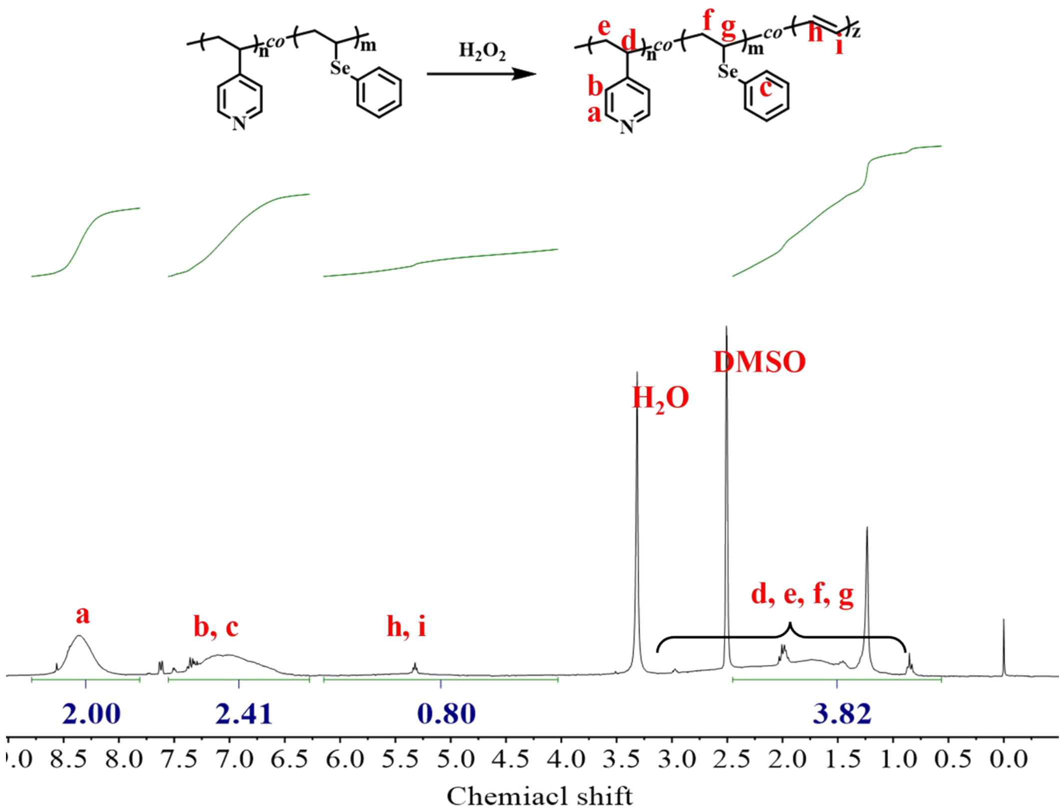


Figure S8. [1]H NMR spectrum of P(PVSe-*co*-4VP) after oxidated by H_2O_2.

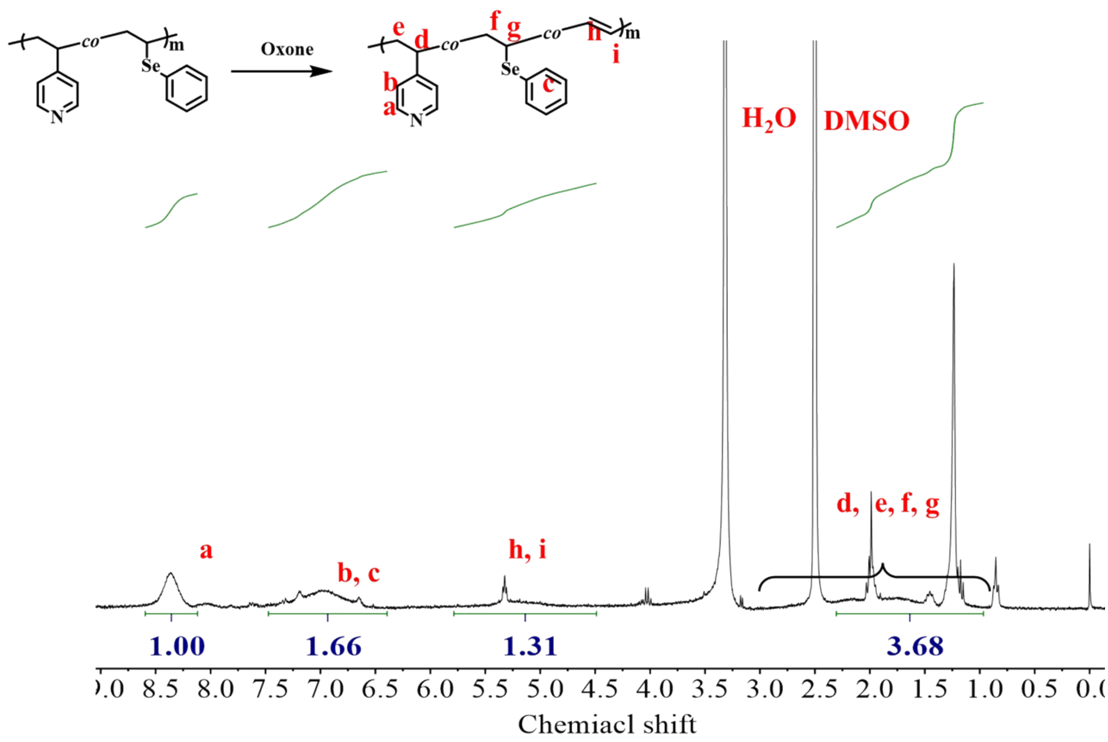


Figure S9. [1]H NMR spectrum of P(PVSe-*co*-4VP) after oxidated by OXONE.

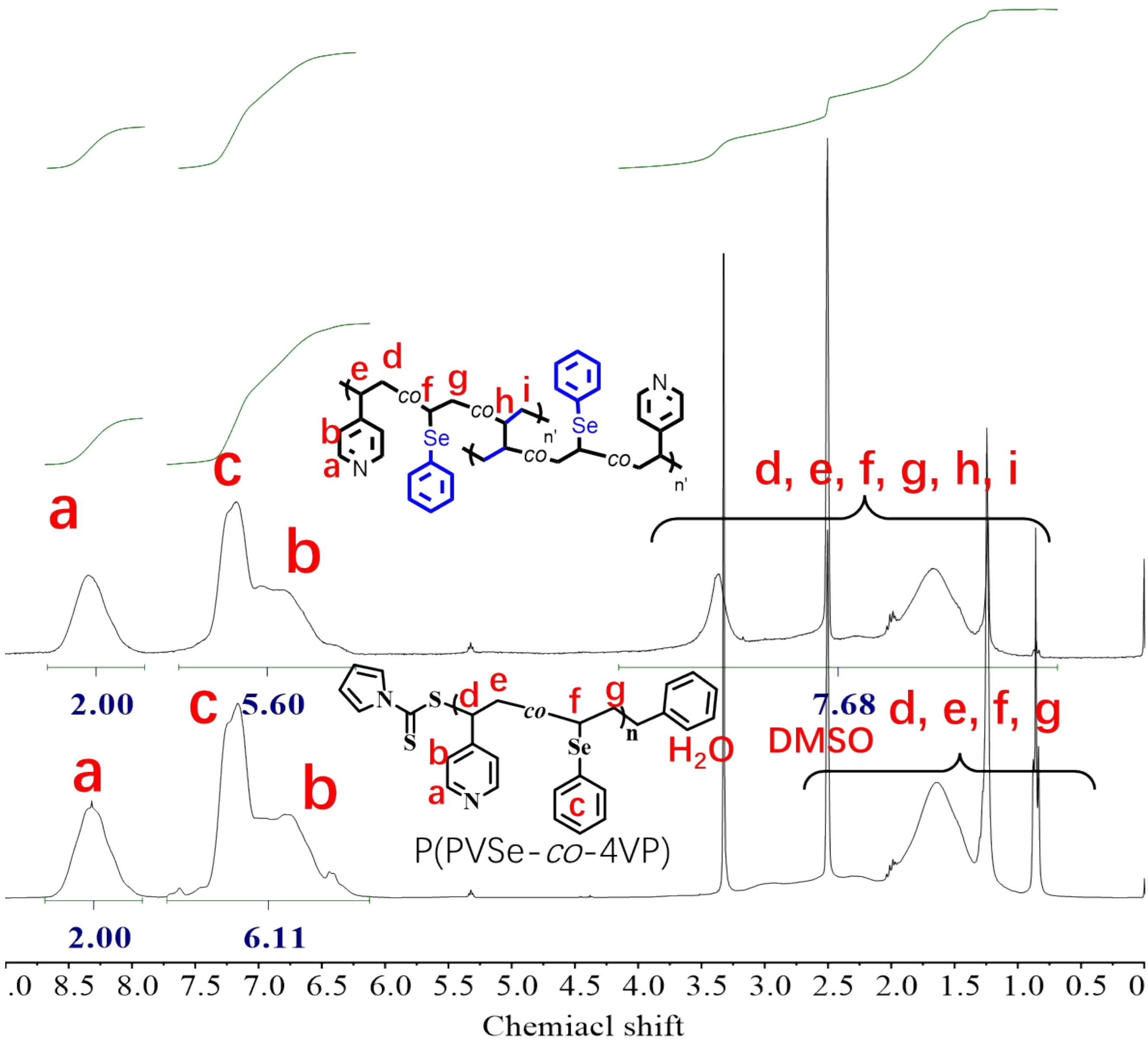
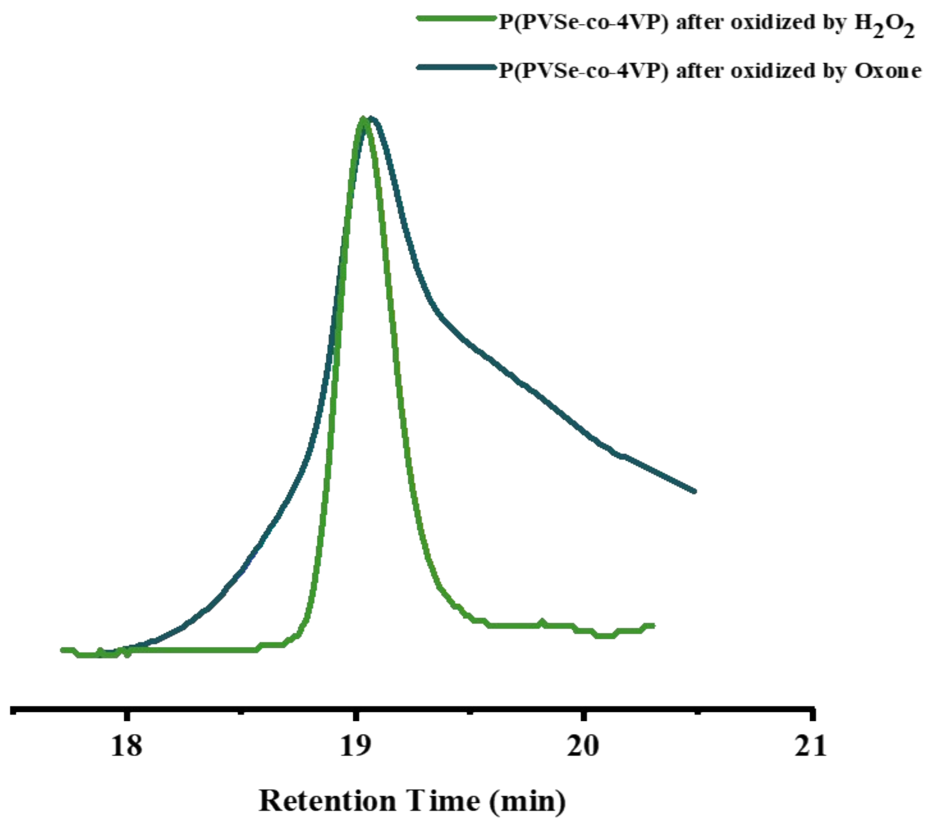


Figure S10. [1]H NMR spectrum of P(PVSe-*co*-4VP) before and after irradiated by ultraviolet (365 nm) for one night.

a



b

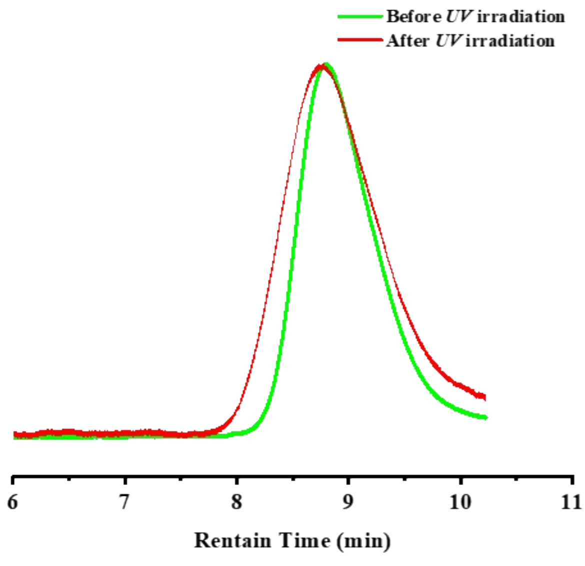


Figure S11. a) SEC traces (water with 0.2 M NaCl+0.03 M NaN3) of P(PVSe-*co*-4VP) after oxidated by H_2O_2.and Oxone; b) SEC traces of P(PVSe-*co*-4VP) before and after irradiated by ultraviolet (365 nm) for one night.

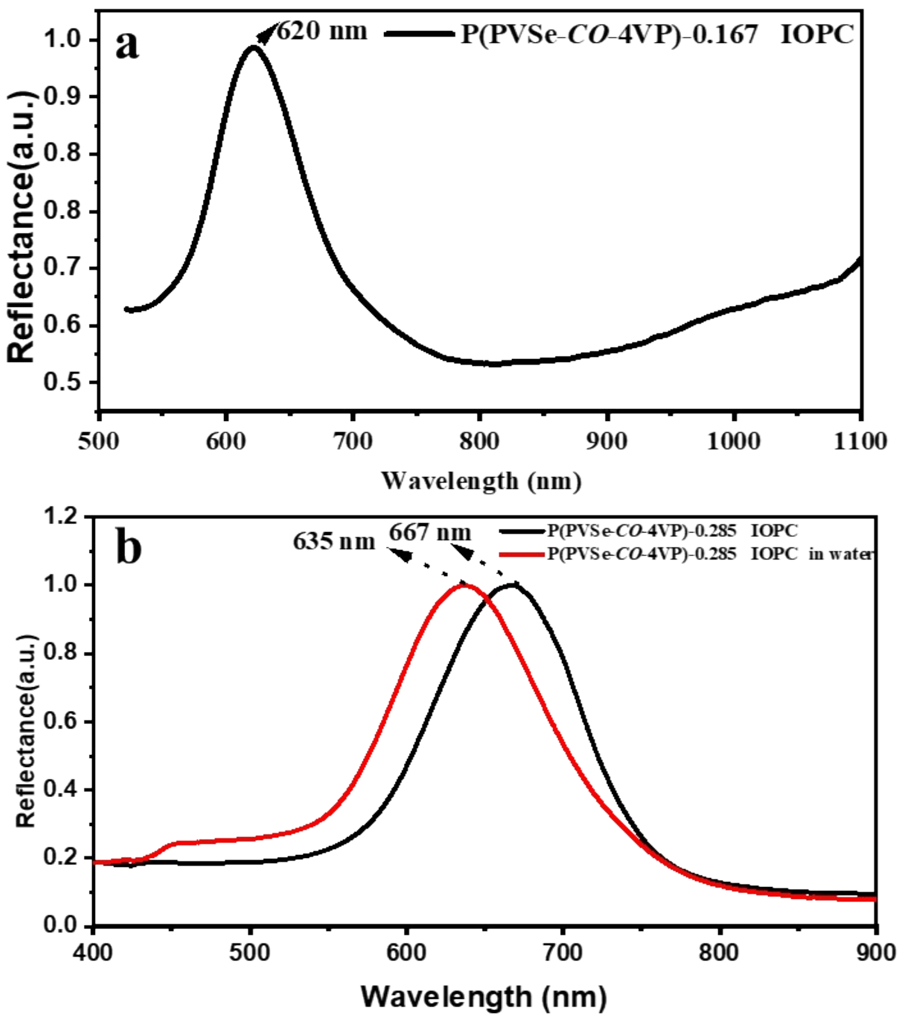


Figure S12. a). The normalized reflectance spectrum of the P(PVSe-*co*-4VP)-0.167 IOPC (the number following P(PVSe-*co*-4VP) is F_{PVSe}); b). The normalized reflectance spectrum of the P(PVSe-*co*-4VP)-0.285 IOPC and when it is in water.

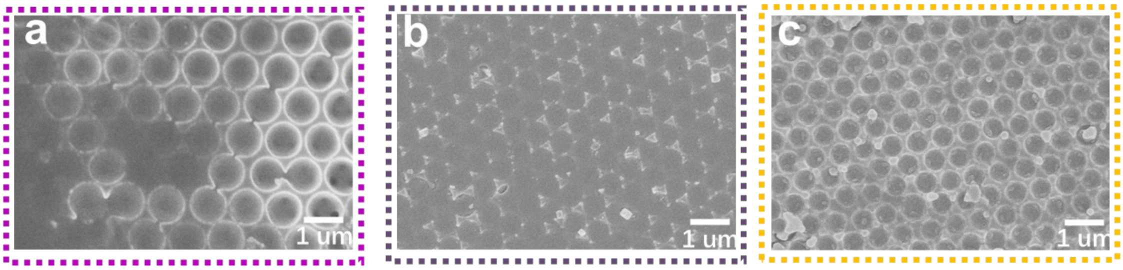


Figure S13. a) SEM image of P(PVSe-co-4VP)-SiO_2 PC after oxidated by 1 $_{wt}$% Oxone; b) SEM image of P(PVSe-co-4VP)-SiO_2 PC after oxidated by 1 $_{wt}$% H_2O_2; c) SEM image of P(PVSe-co-4VP)-SiO_2 PC after irradiated by U*v*.