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Supporting Information

Intrinsically Stretchable Isoindigo-Bithiophene Conjugated Copolymers using Polyacrylateamide Side Chains for Organic Field-Effect Transistors

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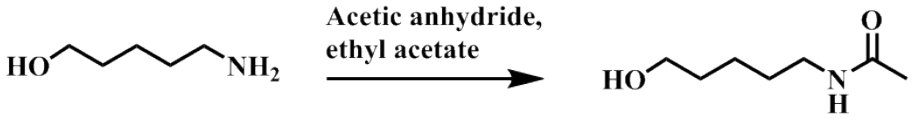
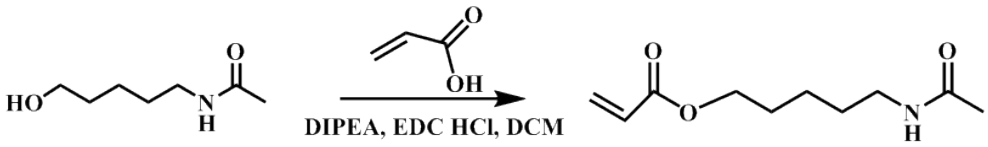
†Electronic Supplementary Information (ESI) available: [details of any supplementary information available should be included here]. See DOI: 10.1039/x0xx00000x

Synthesis of 5-acetamido-1-pentanol (AAP)



5-Amino-1-pentanol (26 mL, 0.25 mol) was dissolved in ethyl acetate (500 mL), followed by the addition of acetic anhydride (25.8 mL, 0.275 mol) dropwise. After being stirred for 3 h at room temperature, the mixture was vacuum dried at room temperature to evaporate the solvent. ^{1}H-NMR (400 MHz, DMSO-d_6), δ(ppm): 7.76 (s, N-H), 3.35-3.38 (br, O-H), 2.97-3.01 (t, NCH_2CH_2), 1.90 (s, OCH_2CH_2), 1.34-1.41 (m, $CH_2CH_2CH_2$), 1.25-1.29 (m, $CH_2CH_2CH_2$).

Synthesis of 5-acetylaminopentyl acrylate (AAPA)



AAP (15 g, 0.103 mol) was added to a solution of acrylic acid (11.2 g, 0.154 mol), EDC·HCl (32.7 g, 0.17 mol) and DIPEA (28 mL, 0.17 mol) in DCM (500 mL). The mixture was stirred at room temperature for 24 h. Another 500 mL DCM was added and the mixture was washed sequentially with 1000 mL 1 M NaOH, 1 M HCl, saturated $NaHCO_3$ and brine. The organic phase was dried over $MgSO_4$, filtered, and the solvent was removed under reduced pressure. The crude product was purified by column chromatography with ethyl acetate, and the pure fractions combined and evaporated to give 18.9 g (91% yield). ^{1}H-NMR (400 MHz, DMSO-d_6), δ(ppm): 7.78 (s, N-H), 6.32 (dd, CH_2CH), 6.17 (dd, $CHCH_2C$), 5.94 (dd, $CHCH_2C$), 4.09 (t, OCH_2CH_2), 2.97-3.01 (dd, NCH_2CH_2), 1.77 (s, $OCCH_3$), 1.58-1.62 (m, $CH_2CH_2CH_2$), 1.38-1.40 (m, $CH_2CH_2CH_2$), 1.29-1.32 (m, $CH_2CH_2CH_2$).

Table S1 Molecular weight characterization of PAAm by NMR, MALDI-TOF and SEC.

	$M_{n,NMR}$ [a]	$M_{n,MALDI-TOF}$ [b]	$M_{n,SEC}$ [c]	PDI [c]
PAAm5	1191	1412	3236	1.10
PAAm10	2188	2408	4594	1.06

a. The molecular weight of PAAm calculated based on the conversion from the signal for 1-H NMR at 4.05 (AAPA) and 3.95 (PAAm). b. The molecular weight of PAAm measured from MALDI-TOF mass spectroscopy with RP mode. c. The molecular weight and PDI measured from DMF eluted GPC.

Table S2 Relevant crystallographic parameters of P1 to P4 thin films under a strain from 0 to 100%.

		P1	P2	P3	P4
Strain(%)	Direction[a]	Lamellar spacing (Å)			
0	**-**	**21.3**	**20.9**	**20.7**	**20.7**
20	∥	20.7	20.7	20.7	20.4
20	⊥	**20.4**	**20.4**	**20.4**	**20.4**
60	∥	19.9	20.4	20.4	20.4
60	⊥	**20.4**	**20.4**	**20.4**	**20.4**
100	∥	20.4	19.9	20.4	20.4
100	⊥	**20.4**	**20.4**	**20.4**	**20.4**

a. The strain direction is parallel or perpendicular to the charge transporting direction.

Table S3 FET Characterization of P1 to P4 thin films under a strain from 0 to 100%.

Strain[a] (%)	∥/⊥ [b]	P1			P2			P3			P4		
		μ_h^{avg} [c]	I_{on}/I_{off}	V_{th}	μ_h^{avg} [c]	I_{on}/I_{off}	V_{th}	μ_h^{avg} [c]	I_{on}/I_{off}	V_{th}	μ_h^{avg} [c]	I_{on}/I_{off}	V_{th}
0	**-**	**0.078**	**2×10^6**	**-22**	**0.12**	**1×10^8**	**-39**	**0.050**	**2×10^6**	**-28**	**0.027**	**9×10^5**	**-36**
20	∥	0.051	2×10^8	-28	0.10	3×10^5	-10	0.047	7×10^4	-16	0.0083	2×10^4	-10
20	**⊥**	**0.077**	**1×10^9**	**-31**	**0.10**	**7×10^5**	**-29**	**0.053**	**1×10^5**	**-29**	**0.031**	**9×10^4**	**-23**
40	∥	0.050	1×10^9	-32	0.069	2×10^7	-20	0.033	3×10^4	-17	0.0061	8×10^4	-13
40	**⊥**	**0.052**	**1×10^7**	**-29**	**0.060**	**3×10^5**	**-17**	**0.052**	**6×10^4**	**-23**	**0.015**	**1×10^3**	**-24**
60	∥	0.037	2×10^8	-21	0.048	3×10^5	-12	0.013	1×10^5	-10	0.0047	2×10^5	-14
60	**⊥**	**0.040**	**2×10^7**	**-17**	**0.061**	**9×10^4**	**-16**	**0.047**	**8×10^4**	**-15**	**0.011**	**1×10^4**	**-14**
80	∥	0.019	7×10^6	-11	0.024	3×10^6	-10	0.013	5×10^5	-11	0.0027	4×10^7	-10
80	**⊥**	**0.027**	**2×10^6**	**-13**	**0.058**	**4×10^5**	**-17**	**0.036**	**3×10^5**	**-22**	**0.0068**	**1×10^5**	**-14**
100	∥	0.008	6×10^7	-9	0.023	4×10^8	-12	0.005	1×10^5	-8	0.0023	2×10^6	-12
100	**⊥**	**0.014**	**6×10^6**	**-24**	**0.037**	**9×10^4**	**-26**	**0.033**	**9×10^4**	**-16**	**0.0056**	**1×10^8**	**-13**

a. FET characteristics conducted with double printed polymer thin films under a different strain level. b. The strain direction is parallel or perpendicular to the charge transporting direction. c. The mobility is in unit of ($cm^2\ V^{-1}\ s^{-1}$). c. All the FET characteristics were averaged from at least 20 devices from 3 different batches.

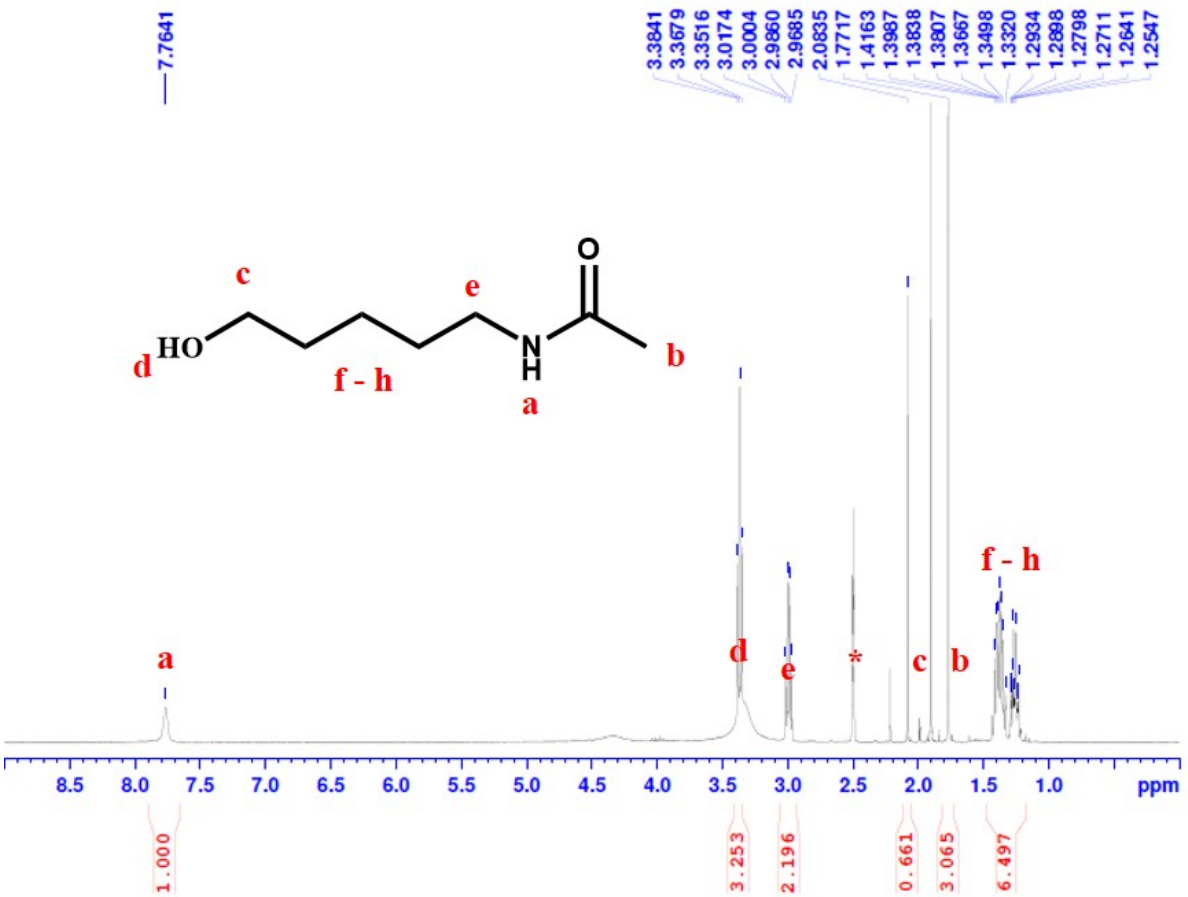


Fig. S1 ^{1}H-NMR of 5-acetamido-1-pentanol (AAP) in DMSO-d_6.

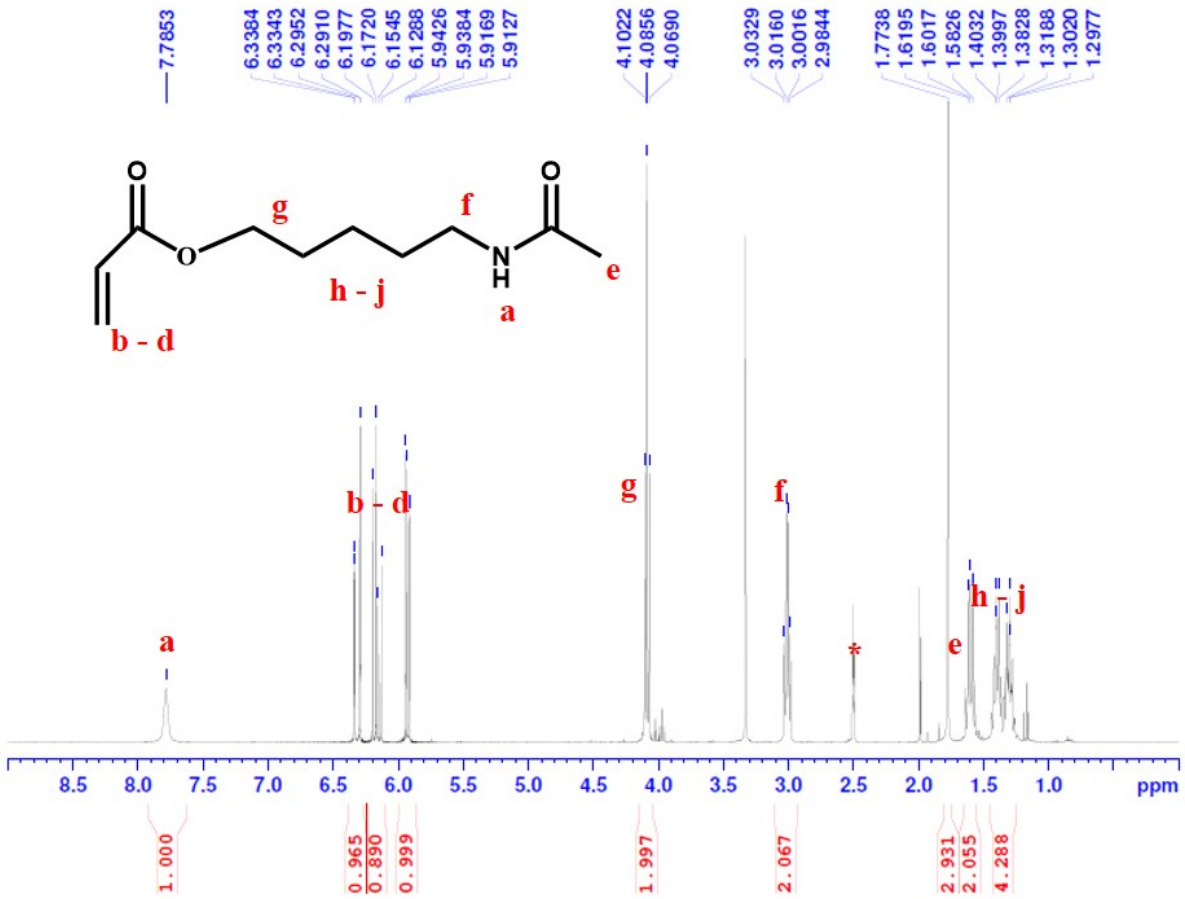


Fig. S2 ^{1}H-NMR of 5-acetylaminopentyl acrylate (AAPA) in DMSO-d_6.

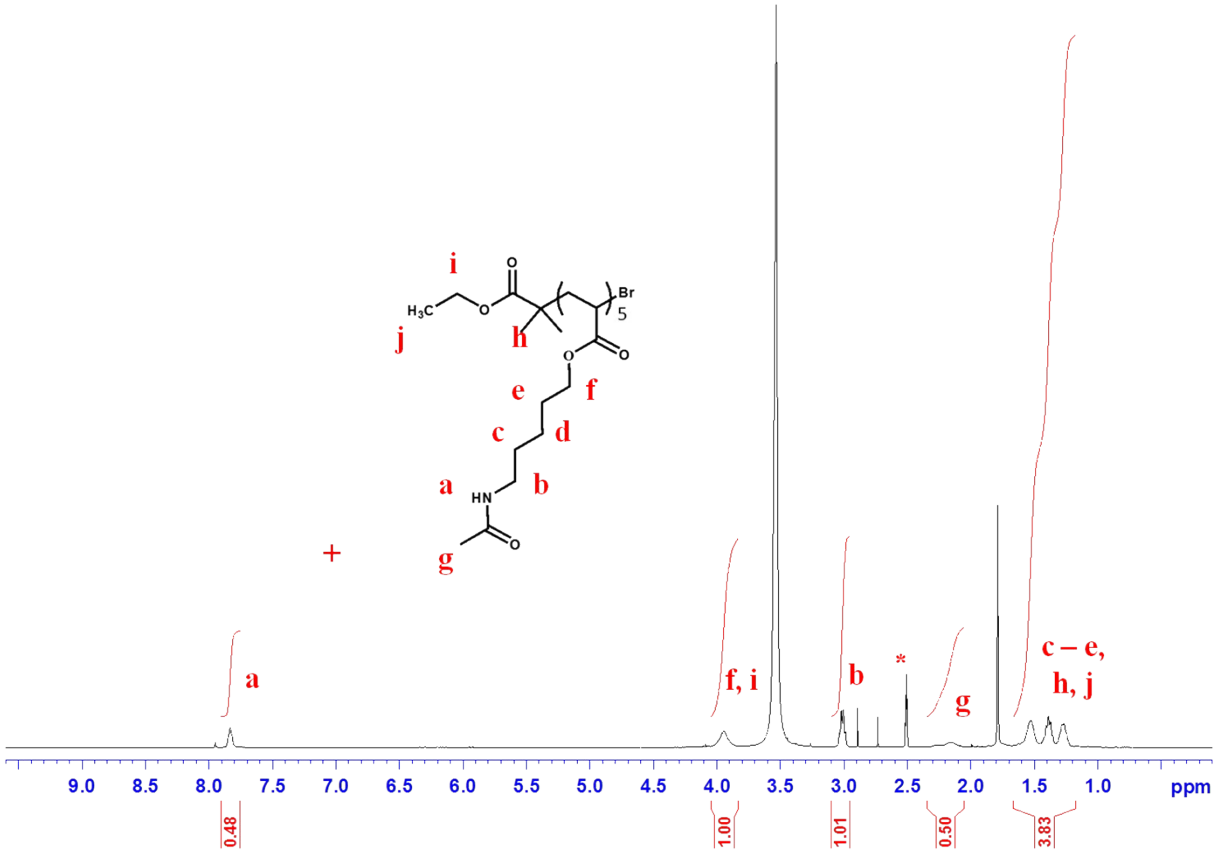


Fig. S3 ^{1}H-NMR of ATRP crude for Poly(5-acetylaminopentyl acrylate) with 5 repeating units (PAAm5) in DMSO-d_6.

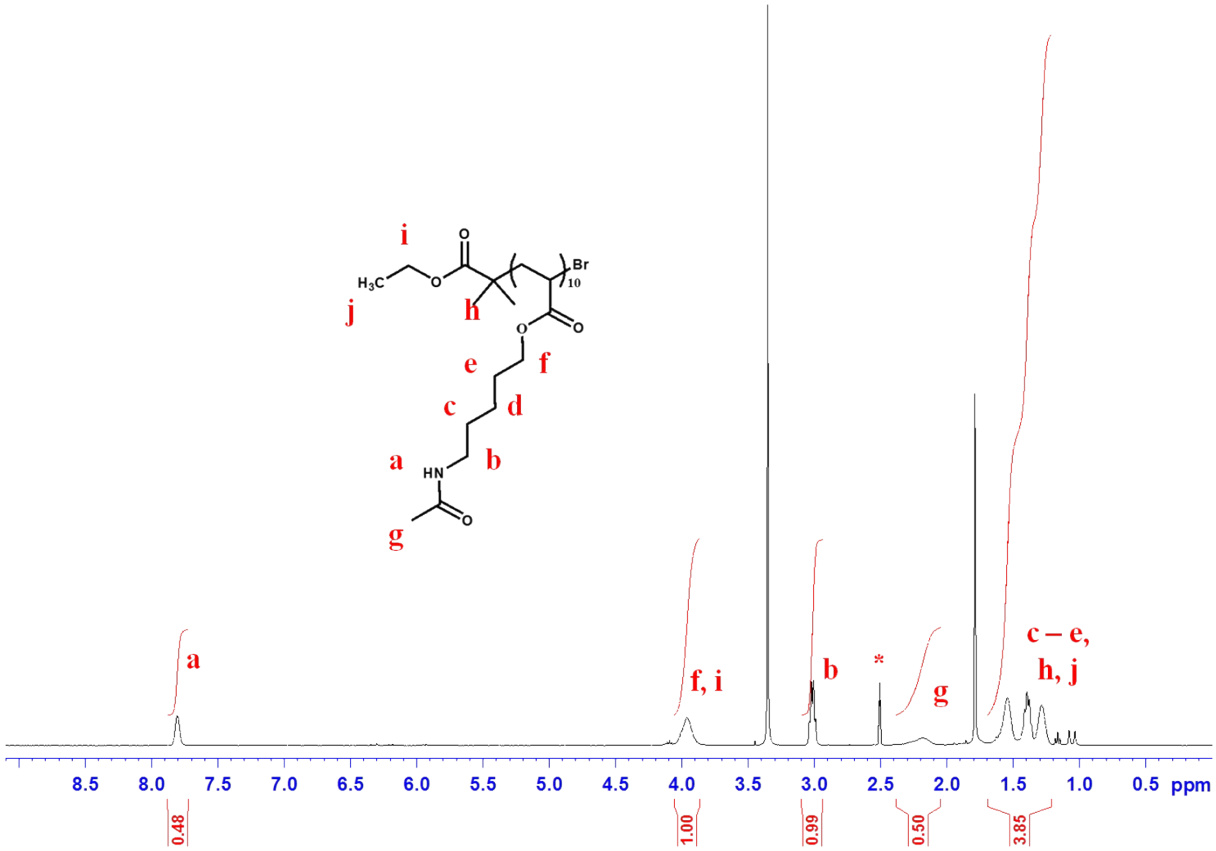


Fig. S4 ^{1}H-NMR of ATRP crude for Poly(5-acetylaminopentyl acrylate) with 10 repeating units (PAAm10) in DMSO-d_6.

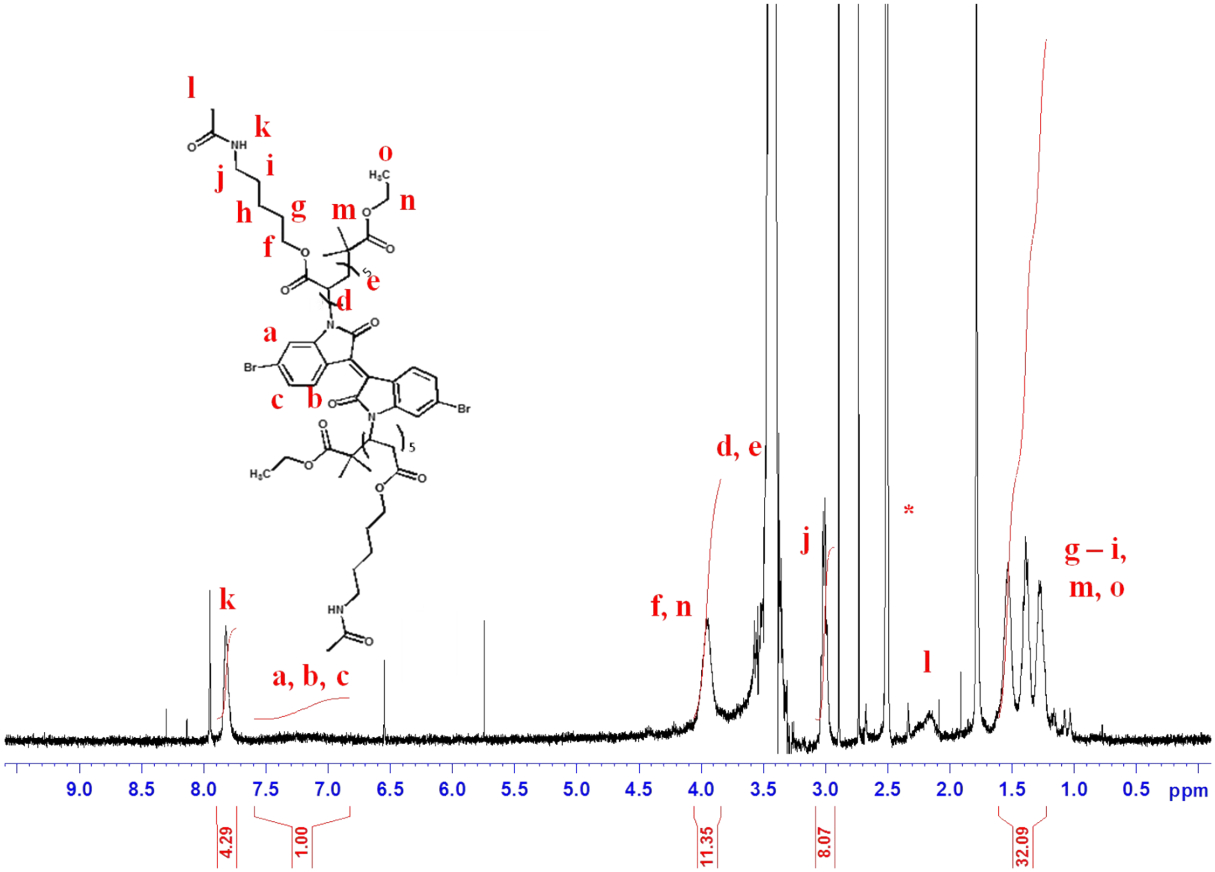


Fig. S5 ^{1}H-NMR of IID-PAAm5 in DMSO-d_6.

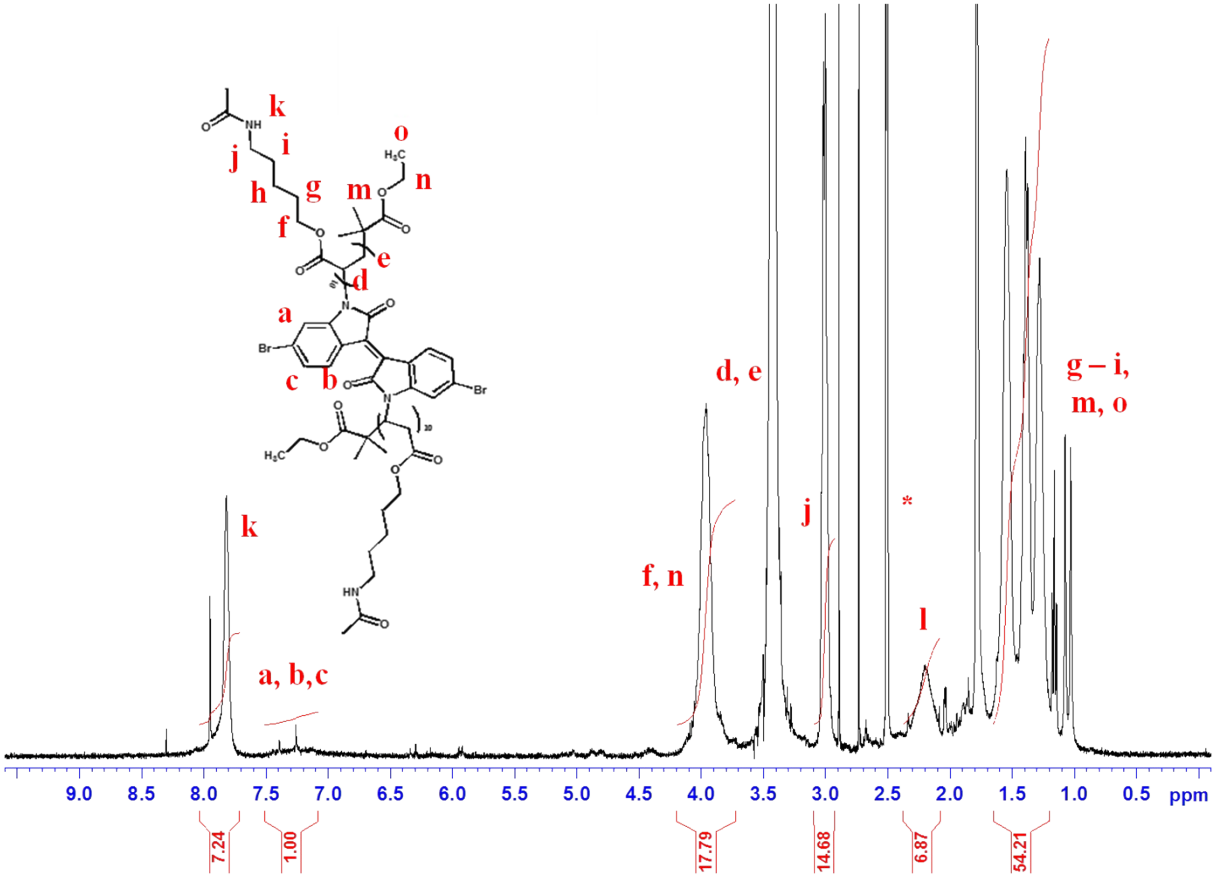


Fig. S6 ^{1}H-NMR of IID-PAAm10 in DMSO-d_6.

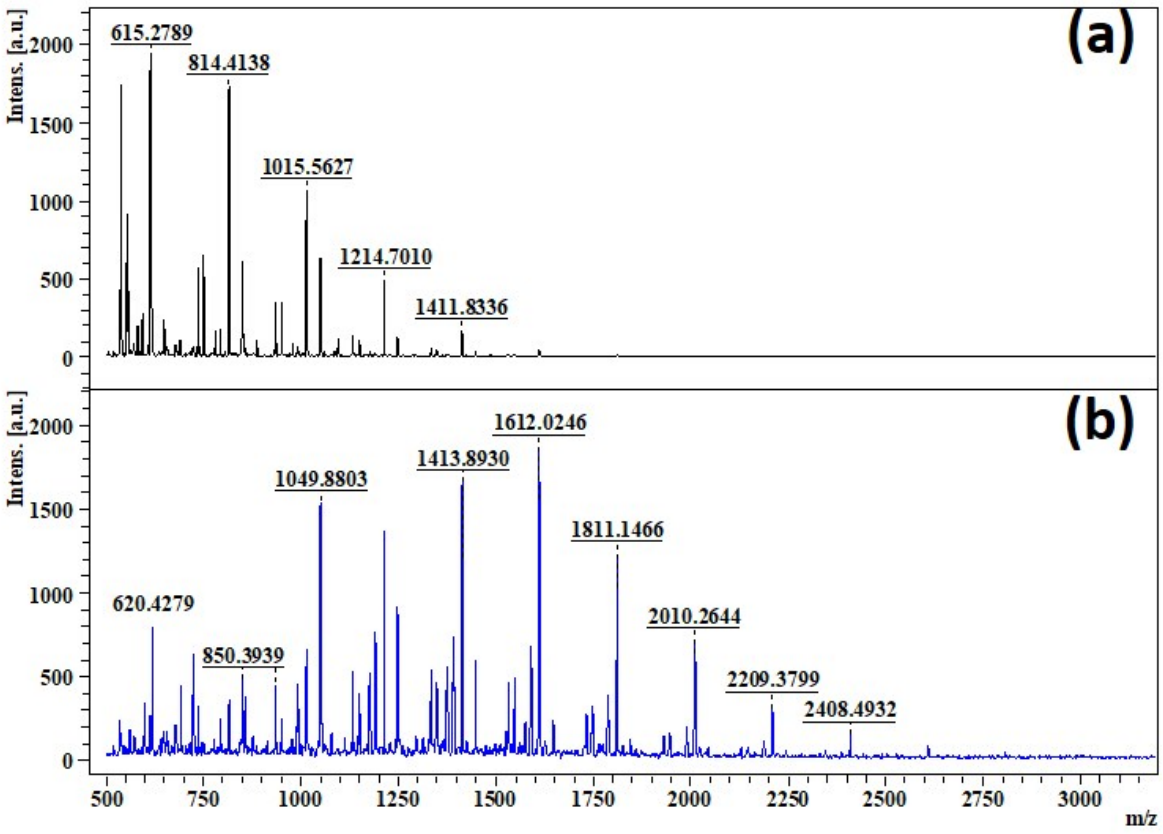


Fig. S7 MALDI-TOF mass spectroscopy of (a) PAAm5 (b) PAAm10.

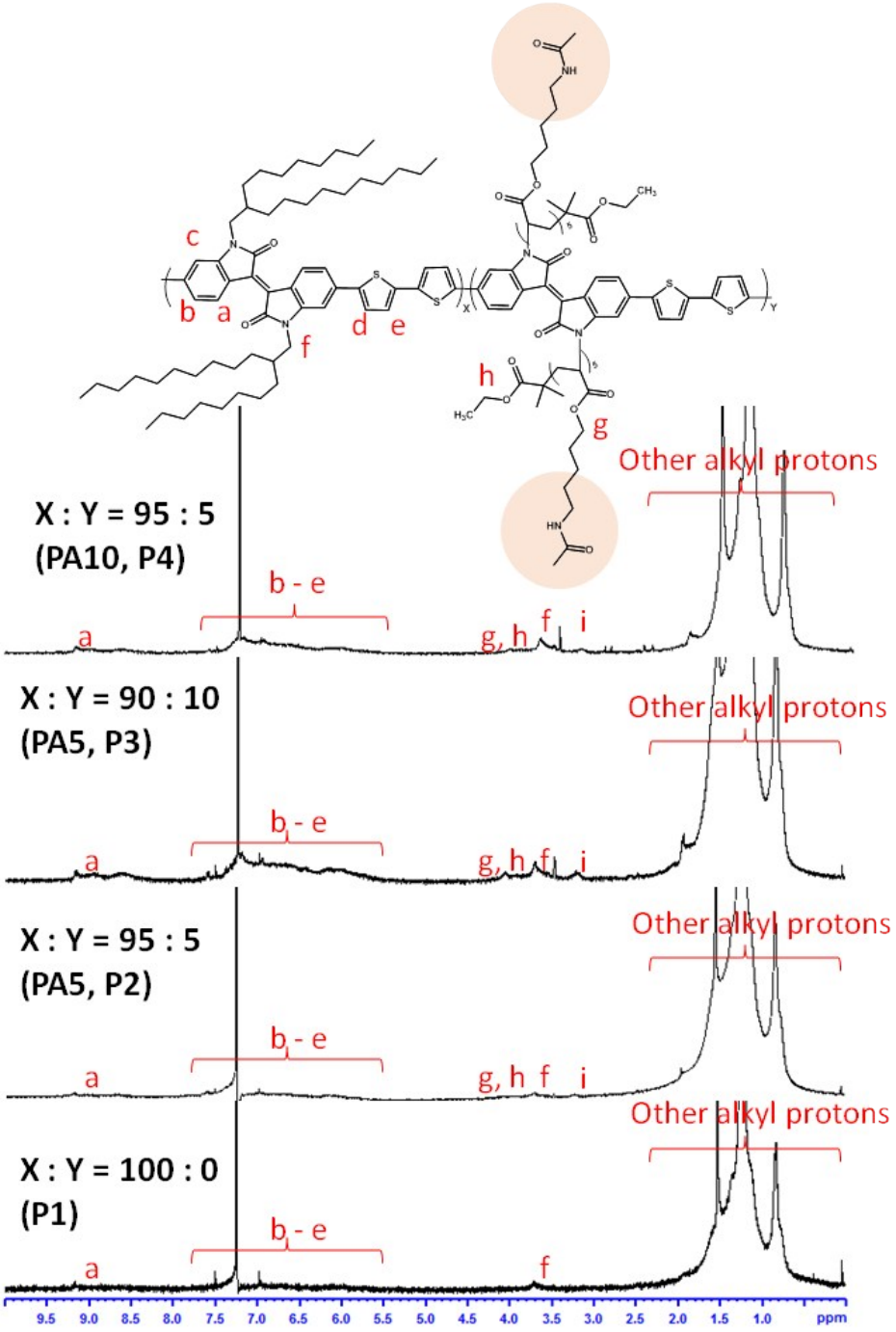


Fig. S8 ^{1}H-NMR of **P1**-**P4** in $CDCl_3$.

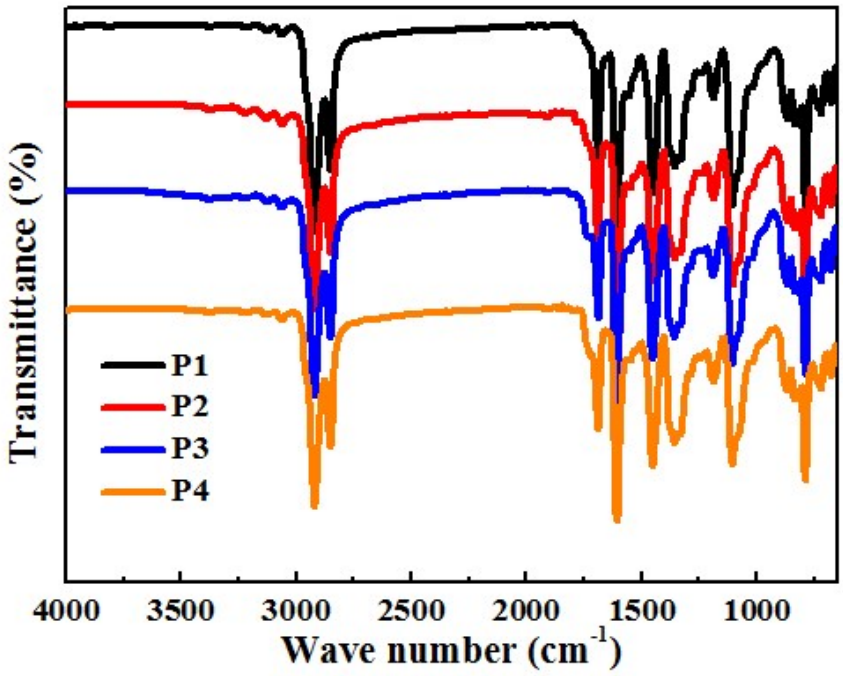


Fig. S9 FTIR spectra of **P1** to **P4**.

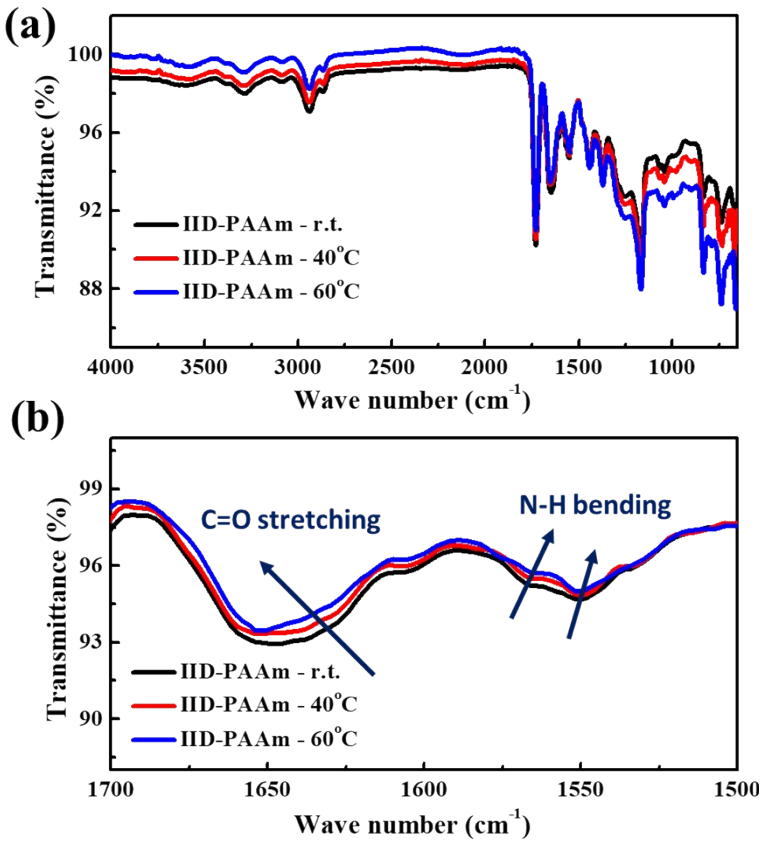


Fig. S10 Variable-temperature FTIR spectra of (a) IID-PAAm (b) in amide NH stretching region.

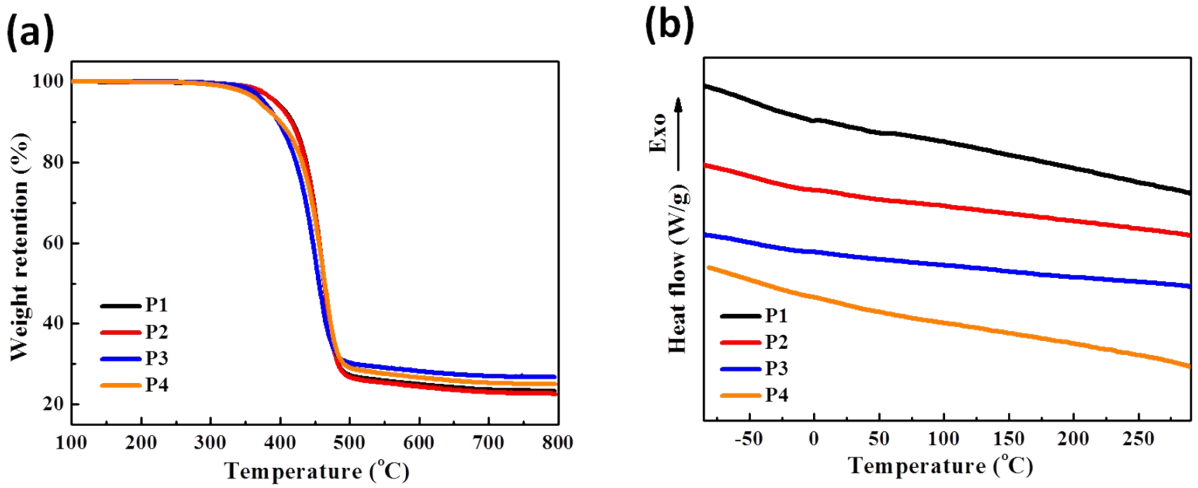


Fig. S11 Material thermal analysis of **P1** to **P4** (a) TGA, (b) DSC.

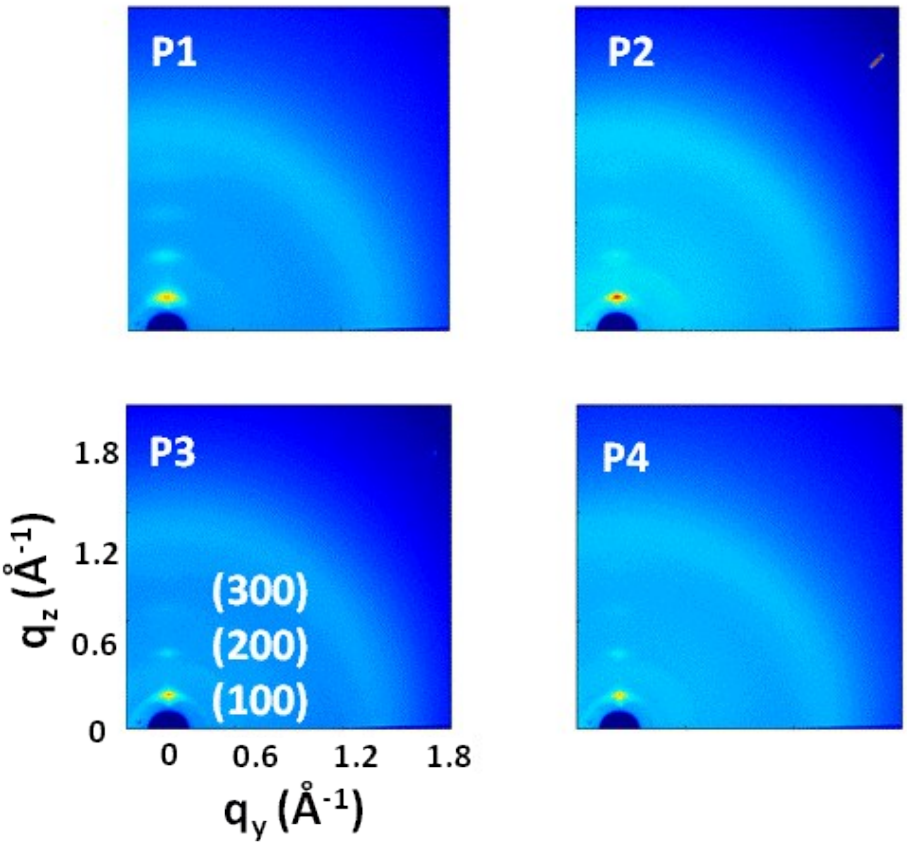


Fig. S12 2D GIXD patterns for **P1** to **P4**.

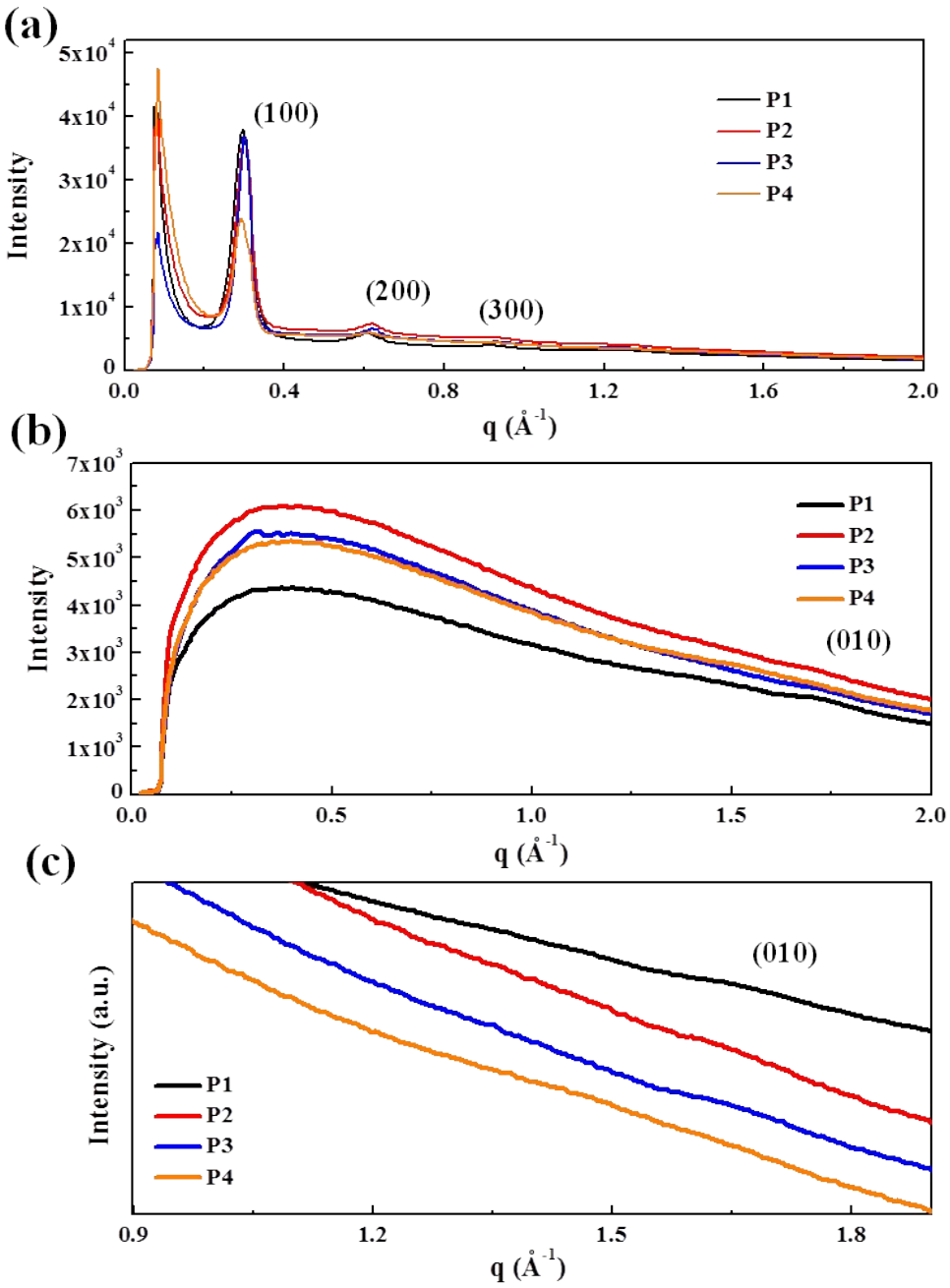


Fig. S13 (a) Whole range out-of-plane profiles, (b) whole range in-plane 1D X-ray scanning profile (c) in-plane 1D X-ray profiles extended for the pi-pi stacking extracted from 2D GIXD patterns for **P1** to **P4**.

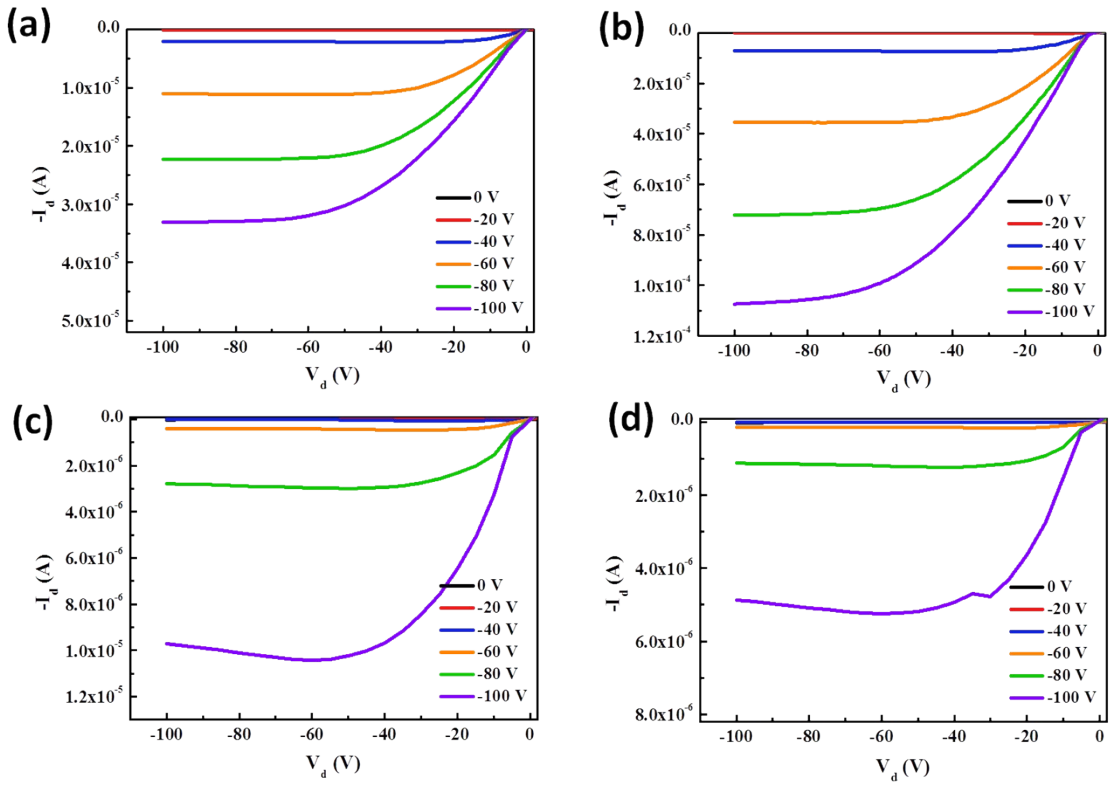


Fig. S14 FET output characteristics of (a) **P1**, (b) **P2**, (c) **P3**, (d) **P4**.

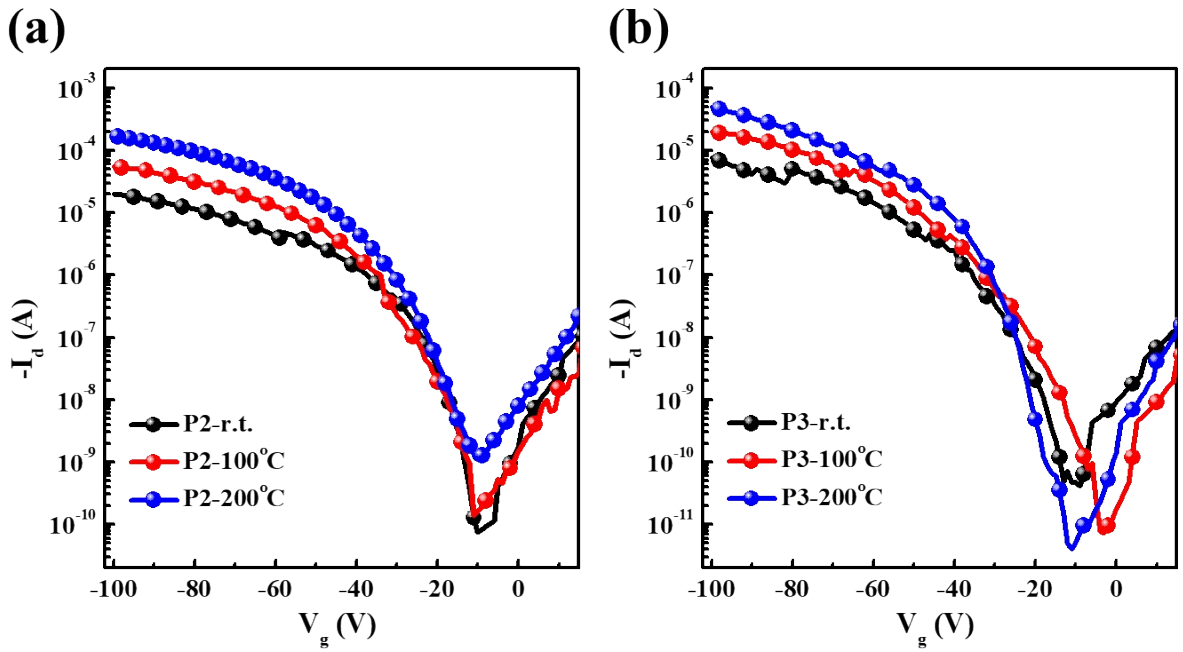


Fig. S15 FET transfer characteristics of (a) **P2** (b) **P3** thin films annealed at different temperature.

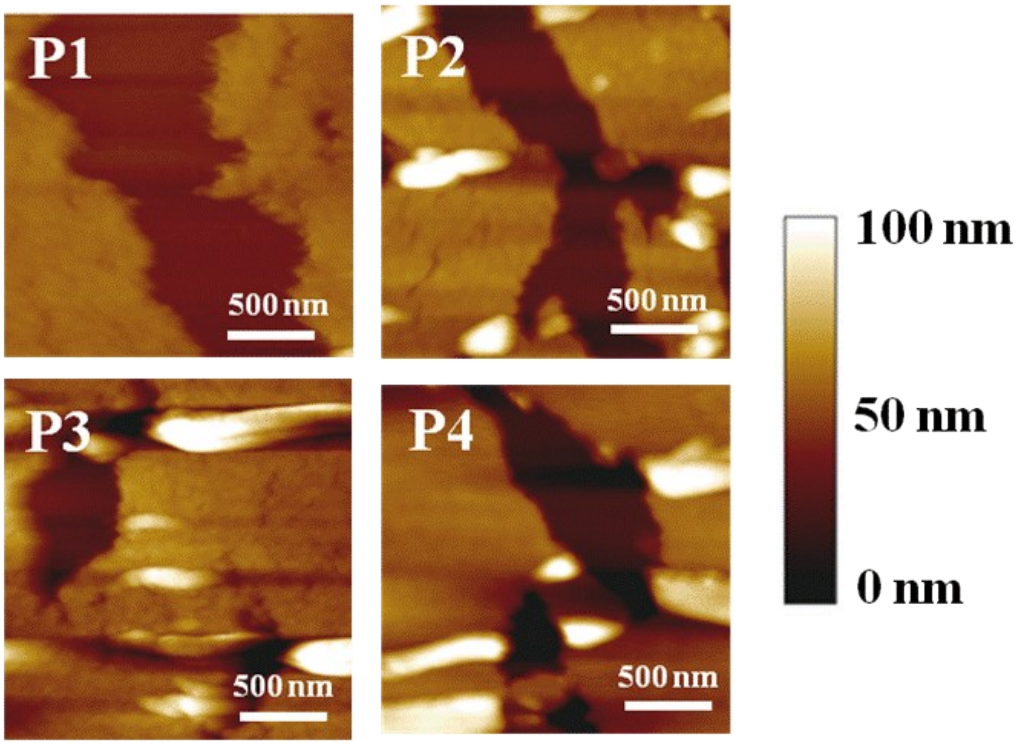


Fig. S16 AFM topographies of **P1** to **P4** thin films under a 80% strain.

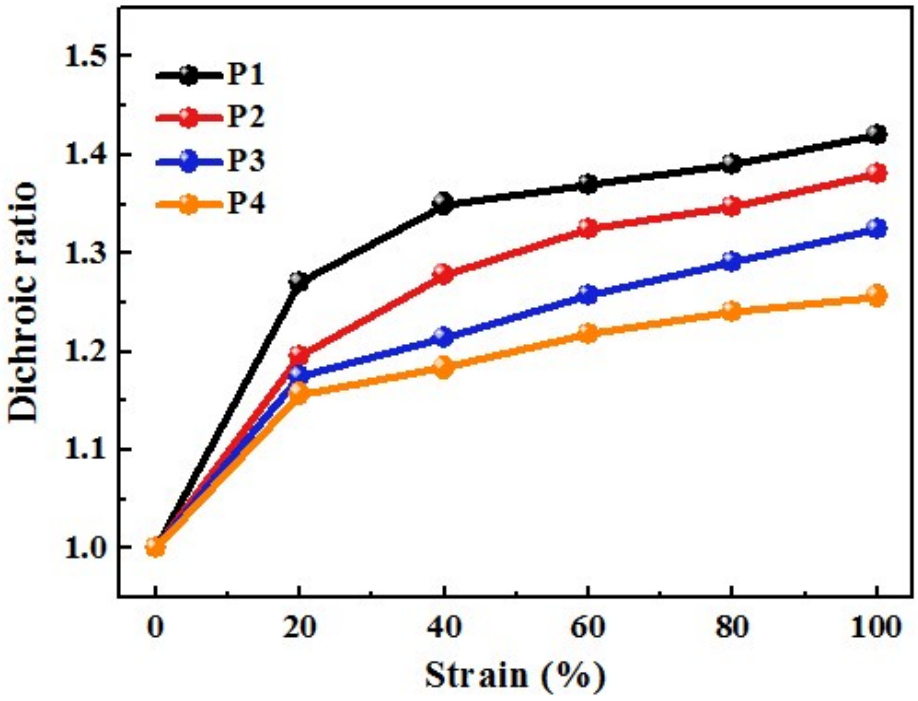


Fig. S17 Dichroic ratio of **P1** to **P4** thin films under a strain from 0 to 100%.

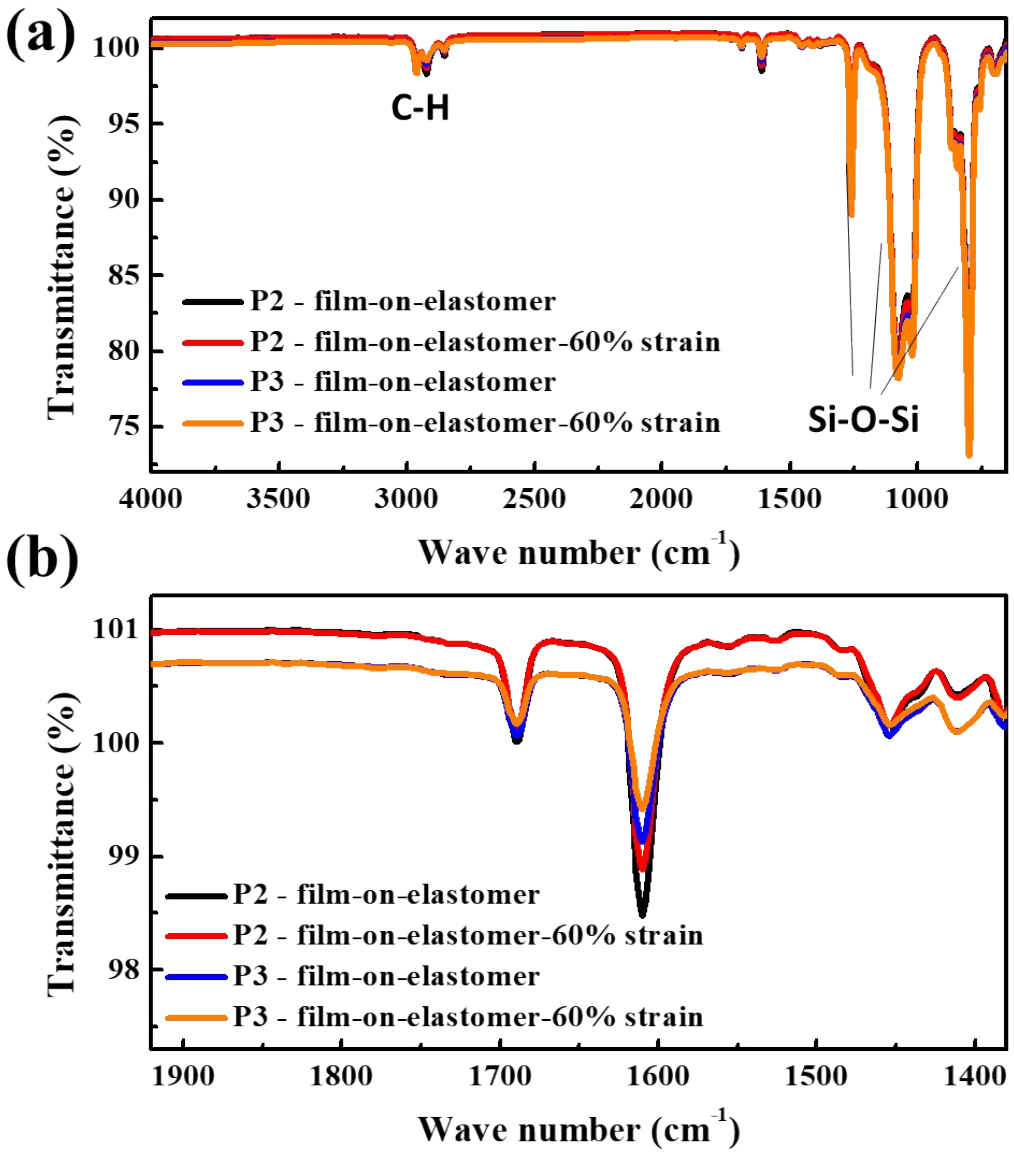


Fig. S18 (a) FTIR spectra for **P2** and **P3** transferred thin films (b) in amide stretching region.

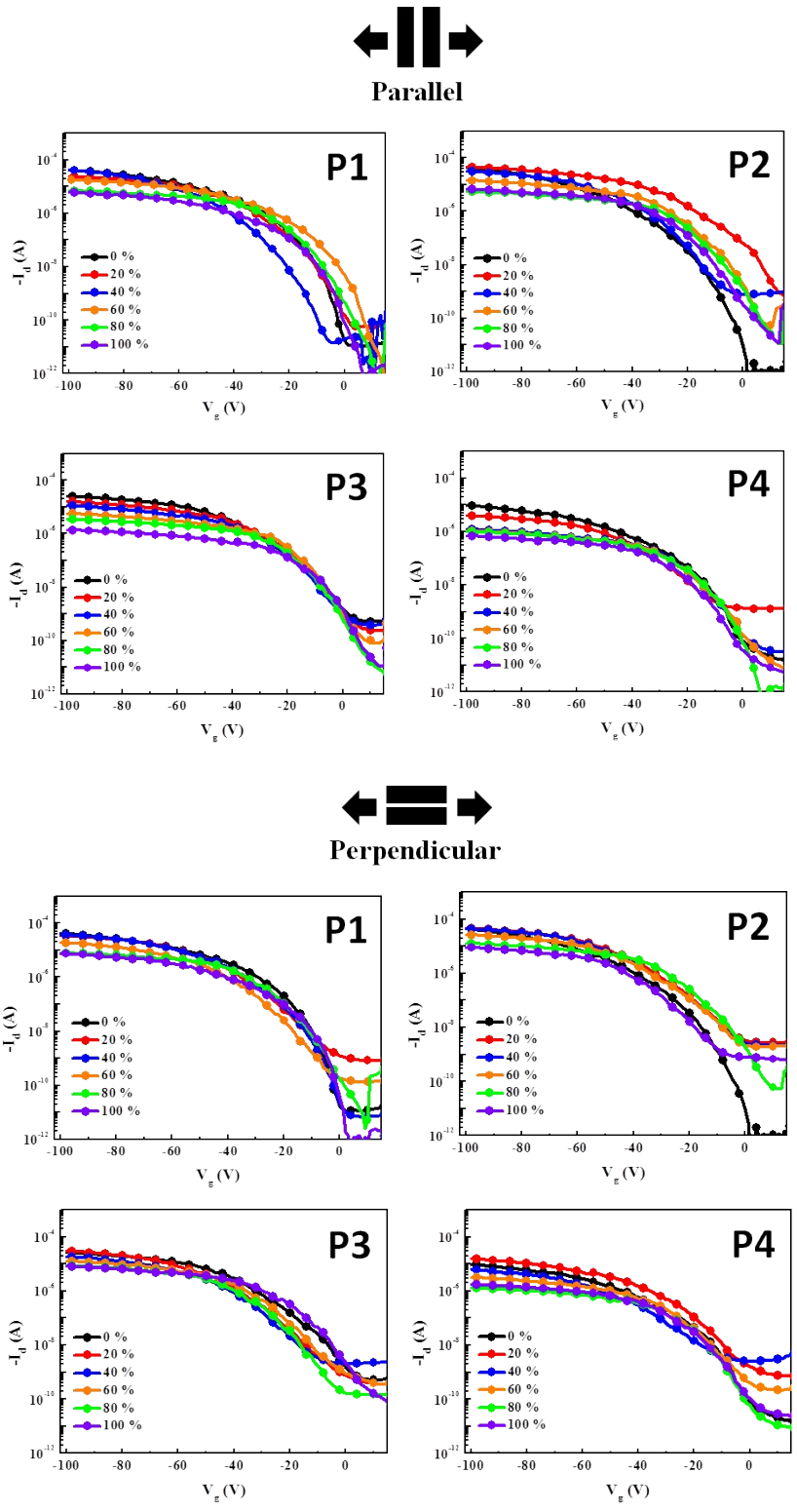


Fig. S19 FET transfer characteristics of **P1** to **P4** double printed thin film under a strain from 0 to 100% for the stretching force parallel or perpendicular to the charge transport direction.

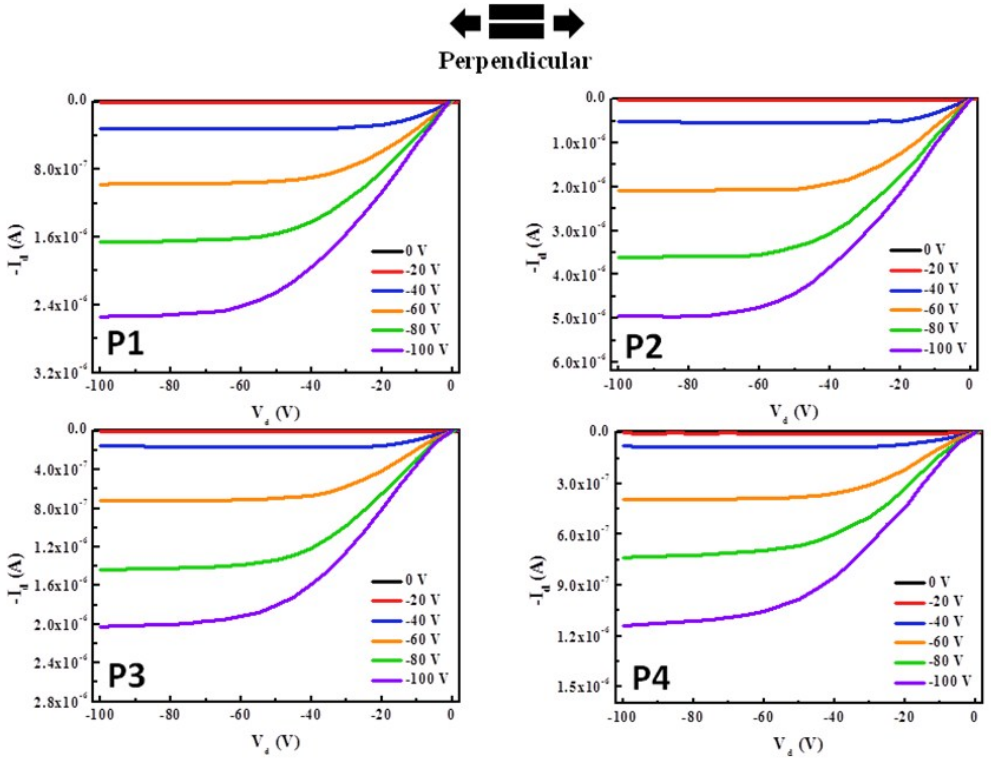


Fig. S20 FET output characteristics of **P1** to **P4** double printed thin film under a 80% strain for the stretching force perpendicular to the charge transport direction.

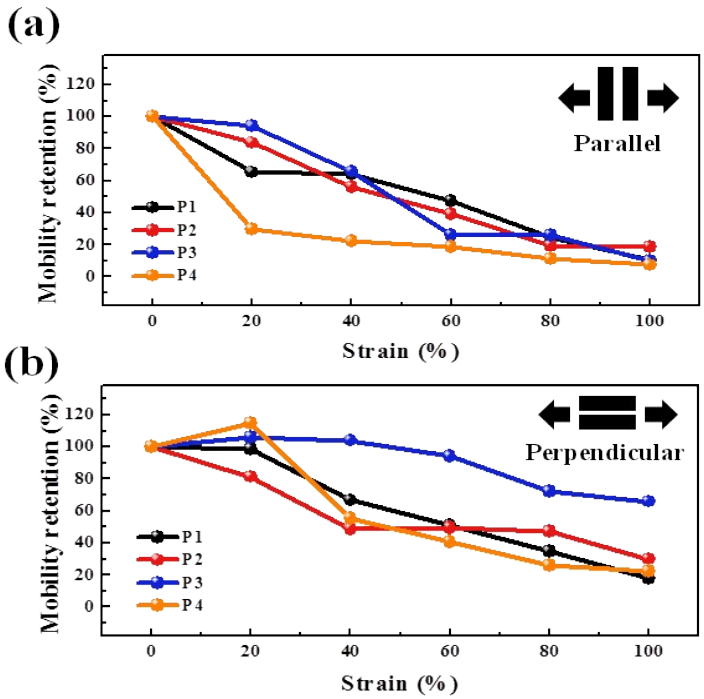


Fig. S21 Averaged FET mobility retention of **P1** to **P4** thin films under a strain from 0 to 100% for the stretching force (a) parallel and (b) perpendicular to the charge transport direction.

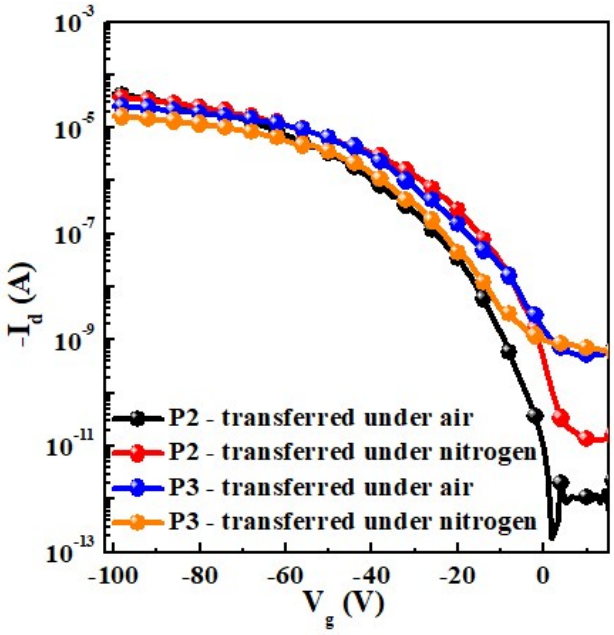


Fig. S22 FET transfer characteristics of **P2** and **P3** thin films double printed under ambient condition and nitrogen atmosphere.

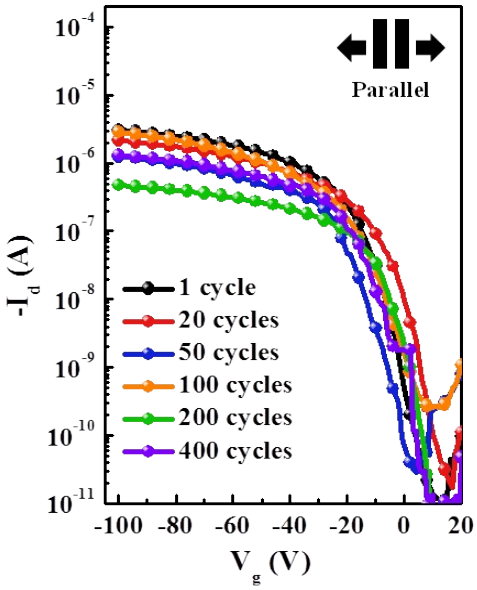


Fig. S23 Transfer curves of the **P2** film were tested under 1, 20 50, 100, 200, and 400 cycles as the charge transport direction is controlled to be parallel to the strain direction.