[Supporting information]

3D printable conductive semi-interpenetrating polymer network hydrogel for neural tissue applications

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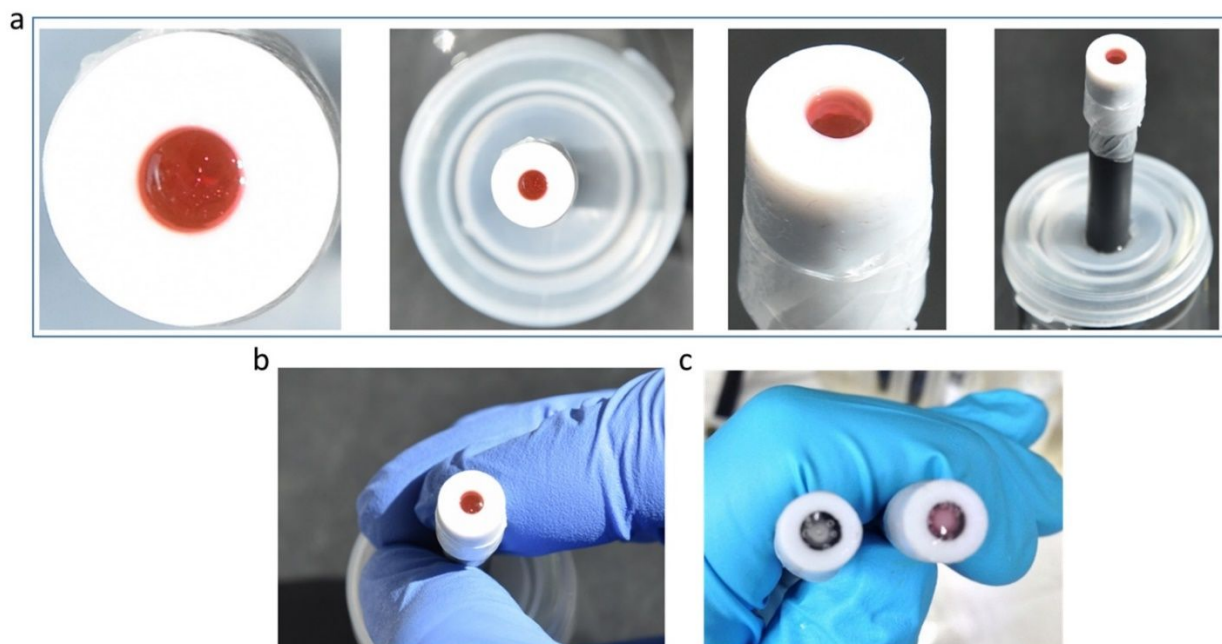⁑Dipartimento di Fisica, Università di Pisa, Largo B. Pontecorvo 3, I-56127 Pisa, Italy

Figure S1. a) Representative images of P(NIPAm-*co*-NIPMAm)/P3HT6S hydrogel-modified electrode polymerized using Teflon caps. b) Electrodes exposed to PBS modified with 0.1 M NaCl electrolyte. c) Electrodes exposed to 0.1 M nBu4NBF4 in acetonitrile showing the damage and dehydration of the hydrogel component.
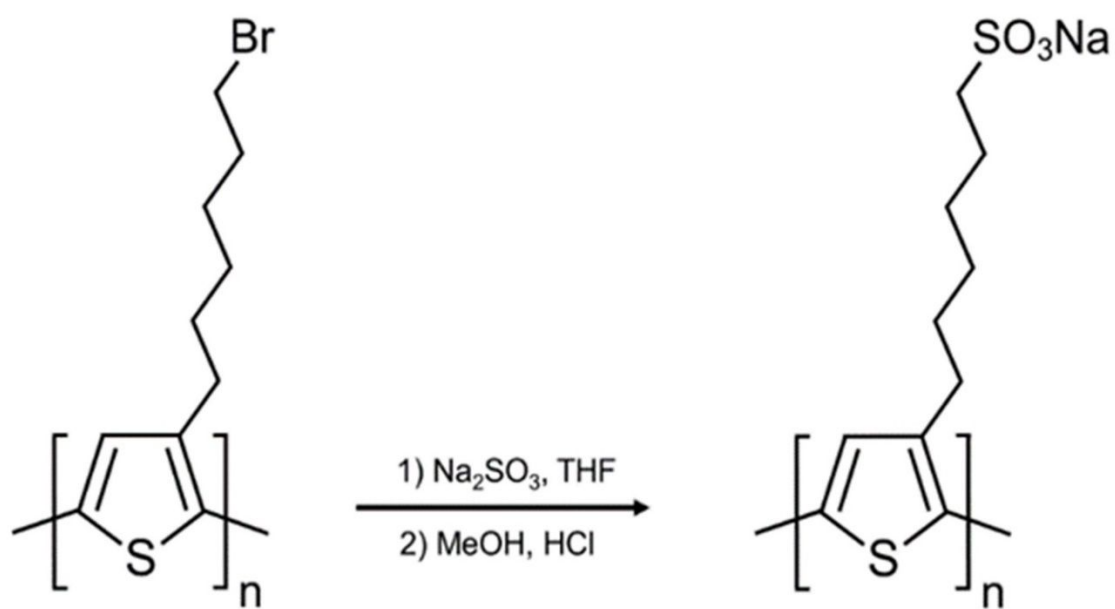
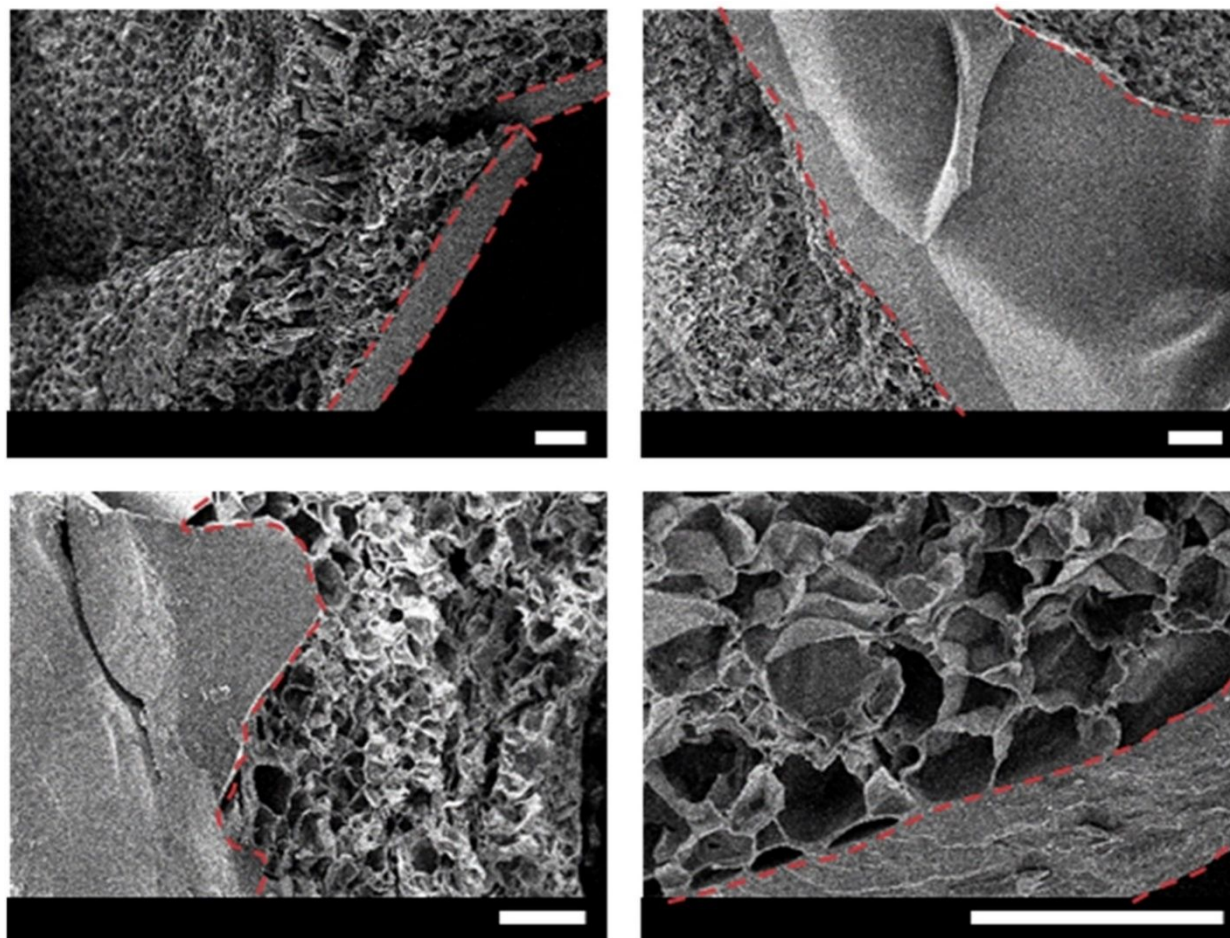**Figure S2.** The synthesis scheme of P3HT6S.

Figure S3. Morphological properties of P(NIPAm-*co*-NIPMAm) hydrogels with the addition of

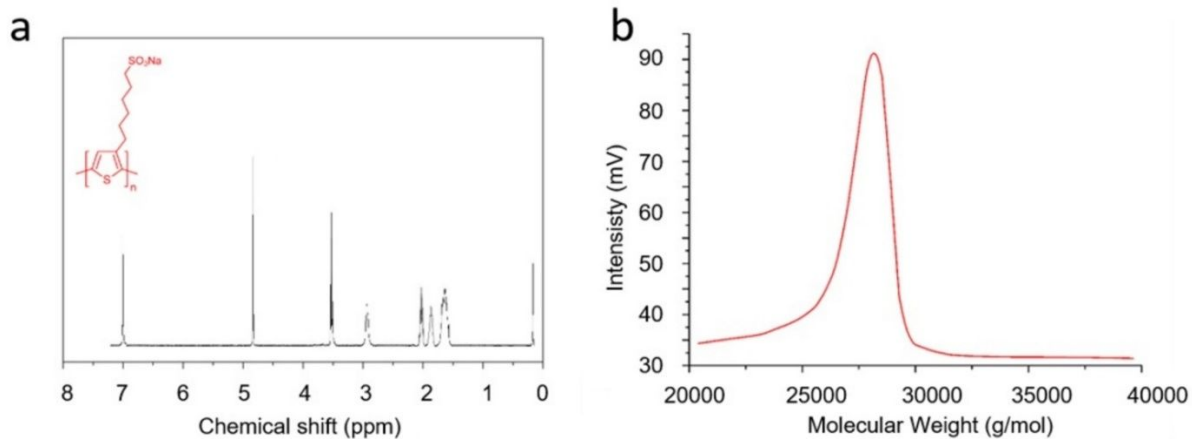P3HT6S > 2%: FE-SEM images showing P3HT6S aggregation (between red dash lines). Scale

bars: 50 μm.

Figure S4. Physical-chemical properties of P3HT6S: a) NMR graph, showing the characteristic peaks of the polymer: ^{1}H-NMR (D$_2$O, ppm): δ 7.01 (s, 1H, Th-H4), 3.43 (t, 2H, -CH_2SO$_3^-$), 2.81 (t, 2H, -CH_2Th), 1.84 (m, 2H, -CH_2CH$_2$SO$_3^-$), 1.73 (m, 2H, -CH_2CH$_2$CH$_2$SO$_3^-$), 1.48 (m, 4H, central methylenes); b) GPC curve, evidencing the peak related to the molecular weight of the polymer.
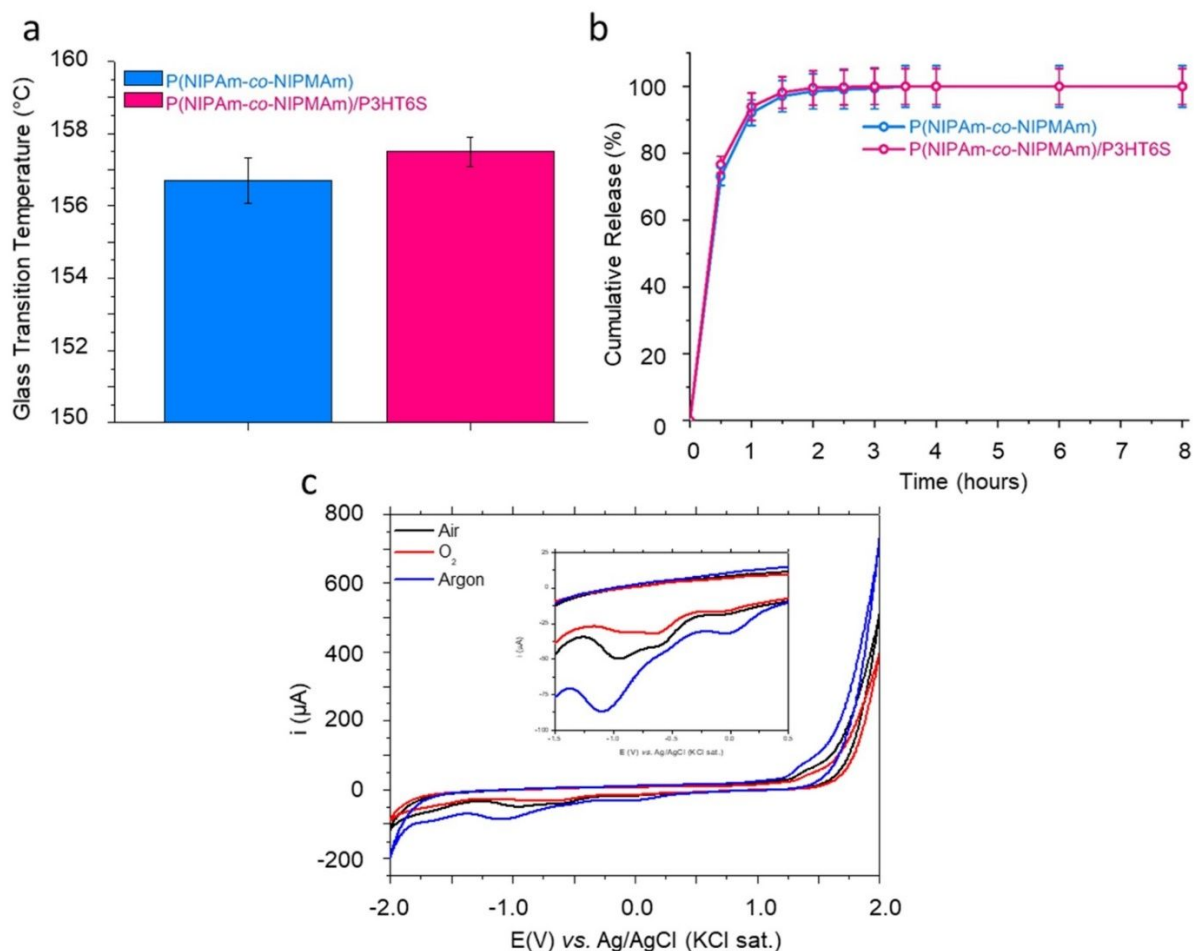
Figure S5. Physical-chemical properties of P(NIPAm-*co*-NIPMAm) and P(NIPAm-*co*-NIPMAm)/P3HT6S hydrogels. a) Glass transition temperature values, reporting no significant differences between the tested samples. b) Photoinitiator cumulative release, showing the total release of the unreacted molecules within 2 hours. c) CV of P(NIPAm-*co*-NIPMAm)/P3HT6S hydrogel-modified GCE measured in standard ambiance environment (air), deoxygenated condition (purging Argon), or when O_2 is purged. Scan rate 0.1 V/s
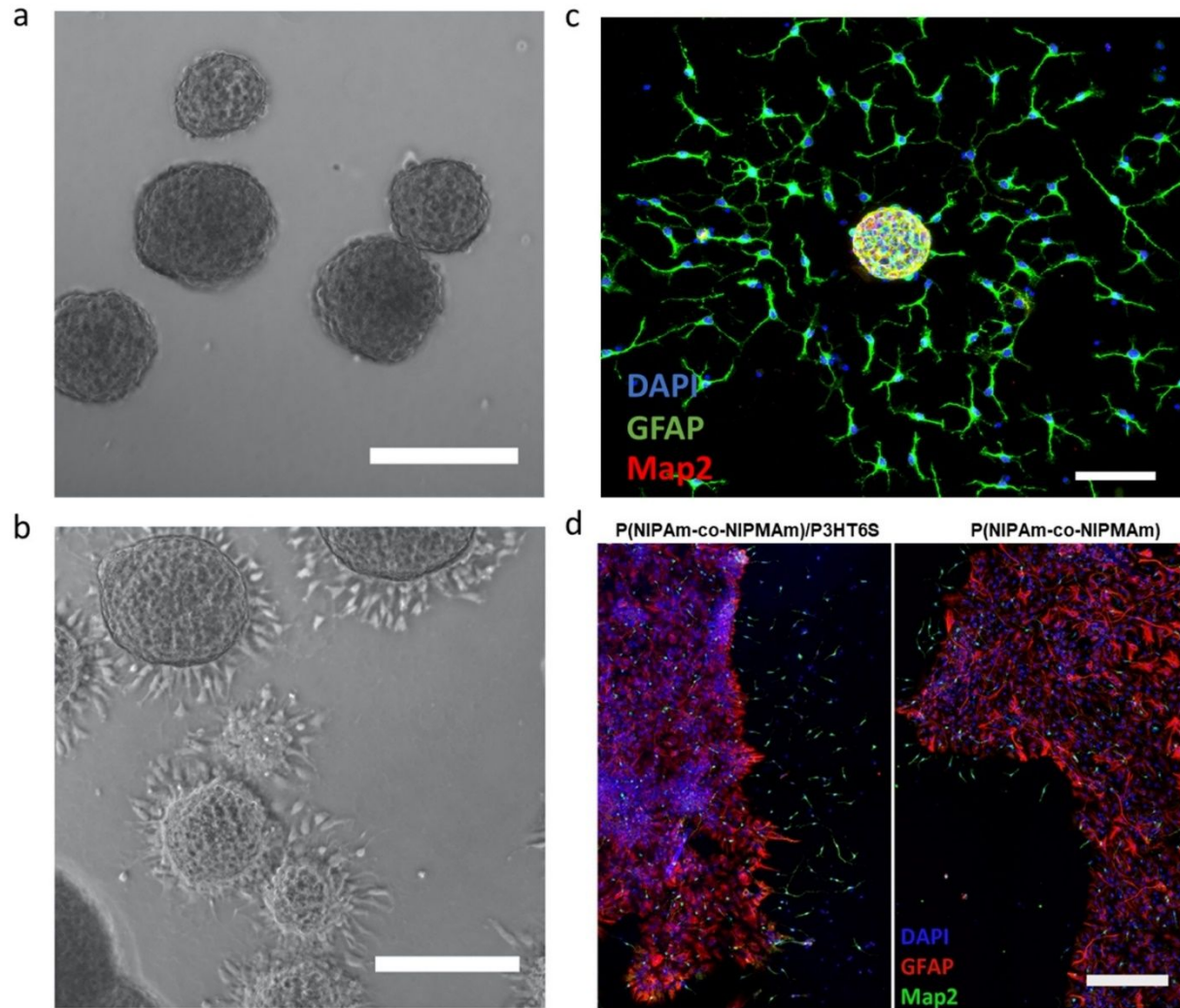
Figure S6. Images of mouse SVZ-neurospheres. a) Bright-field image of neurospheres floating in non-adherent cultures. b-d) Neurospheres seeded on P(NIPAm-*co*-NIPMAm) and P(NIPAm-*co*-NIPMAm)/P3HT6S hydrogels: bright field image of 1 hour cultured neurospheres (b) and confocal image of neurospheres stained against DAPI (Blue), GFAP (RED) and Map2 (Green) during the culture time (c-d). Scale bars: 100 μm.
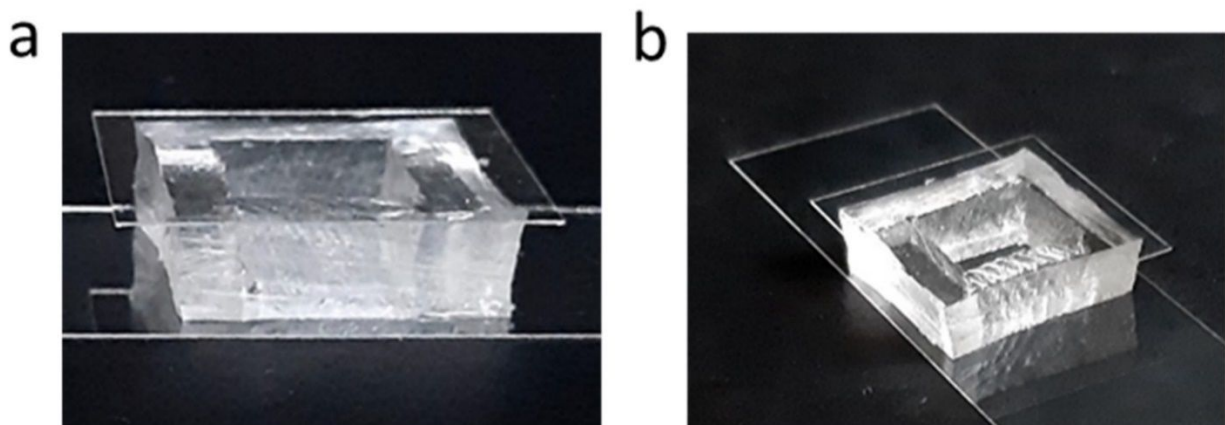
Figure S7. Laser 3D printing of P(NIPAm-*co*-NIPMAm)/P3HT6S hydrogel: macroscopic images of the PDMS chamber front (a) and top (b) views.

Table S1. Codes and recipes of P(NIPAm-*co*-NIPMAm) hydrogels with increasing concentration of P3HT6S.

Hydrogel code	NIPAm (mg; mmol)	NIPMAm (mg; mmol)	BIS (mg; mmol)	Irgacure 2959 (mg; mmol)	P3HT6 (mg)	Volume (mL)
0	46.25; 0.409	1.25; 0.01	2.5; 0.016	10; 0.044	0	1.0
0.02	46.25; 0.409	1.25; 0.01	2.5; 0.016	10; 0.044	0.020	1.0
0.1	46.25; 0.409	1.25; 0.01	2.5; 0.016	10; 0.044	0.102	1.0
0.2	2685	1.25; 0.01	2.5; 0.016	10; 0.044	0.204	1.0
0.5	46.25; 0.409	1.25; 0.01	2.5; 0.016	10; 0.044	0.51	1.0
1	46.25; 0.409	1.25; 0.01	2.5; 0.016	10; 0.044	1.02	1.0

| 2 | 46.25; 0.409 | 1.25; 0.01 | 2.5; 0.016 | 10; 0.044 | 2.04 | 1.0 |

Table S2. Codes and relative percentage composition of polymer constituents of P(NIPAm-*co*-NIPMAm) hydrogels with increasing concentration of P3HT6S.

Hydrogel code	Total hydrogel network concentration (wt %)	P3HT6 concentration relative to the polymer mass (wt %)
0	5	0
0.02	5	0.020
0.1	5	0.102
0.2	5	0.204
0.5	5	0.51
1	5	1.02
2	5	2.04