

Supplementary Materials

Table S1. Gel fraction (W_g), the equilibrium weight (q_w) and volume swelling ratio (q_v) of the cryogels. Standard deviations are given in parenthesis.

Cryogels	W_g	q_w	q_v
AMPS	1.43 (0.07)	138 (3)	1.5 (0.1)
NaMA	1.15 (0.06)	123 (2)	3.3 (0.2)
NaAA	0.97 (0.03)	94 (2)	3.5 (0.6)
DNA	0.99 (0.05)	51 (1)	1.18 (0.04)
AAM	0.88 (0.10)	32 (2)	1.30 (0.04)
DMAA	1.02 (0.03)	32 (1)	1.37 (0.08)
SF	1.03 (0.04)	8.4 (0.3)	1.12 (0.01)

Table S2. Total pore volume (V_p) of the cryogels and their average pore diameters (D) determined by OM and SEM techniques. Standard deviations are given in parenthesis.

Cryogels	$V_p / \text{mL g}^{-1}$	$D / \mu\text{m}$ by OM	$D / \mu\text{m}$ by SEM
NaAA	6.7 (0.1)	42 (4)	52 (5)
SF	10.4 (0.4)	33 (4)	48 (4)
NaMA	10.5 (0.4)		
AMPS	10.6 (0.3)	74 (7)	72 (4)
DNA	12.4 (0.3)	134 (5)	125 (7)
DMAA	14 (1)	207 (15)	202 (9)
AAM	15.6 (0.2)	139 (20)	131 (7)

Table S3. Melting temperatures (T_m) of ice, and frozen solutions of AAm, DMAA, NaAA, NaMA, AMPS, SF, and DNA at a concentration of 5 w/v %. Standard deviations are given in parenthesis.

Aqueous solutions	$T_m / ^\circ\text{C}$
H ₂ O	-0.30 (0.07)
AAm	1.25 (0.11)
DNA	0.90 (0.01)
SF	-0.6 (0.1)
DMAA	-2.3 (0.3)
AMPS	-3.4 (0.1)
NaMA	-6.5 (0.1)
NaAA	-6.6 (0.1)

Table S4. The fraction of unfrozen water (f_{unf}), true concentration of the reactants in unfrozen domains (C_{true}), and ice volume (V_{ice}) in cryogelation systems for various monomers and polymers at -18 °C. Standard deviations are given in parenthesis.

Cryogels	f_{unf} %	C_{true} w/v %	$V_{ice} / \text{mL g}^{-1}$
NaMA	38 (1)	12.2 (0.2)	11.8 (0.1)
NaAA	37.2 (0.3)	12.5 (0.1)	12.0 (0.1)
DNA	32 (1)	14.1 (0.4)	13.0 (0.2)
AMPS	31.5 (1.6)	14.3 (0.1)	13.1 (0.3)
SF	25 (1)	17.5 (0.6)	14.4 (0.2)
AAm	14 (2)	28 (2)	16.5 (0.3)
DMAA	6.5 (1.3)	45 (5)	17.9 (0.2)

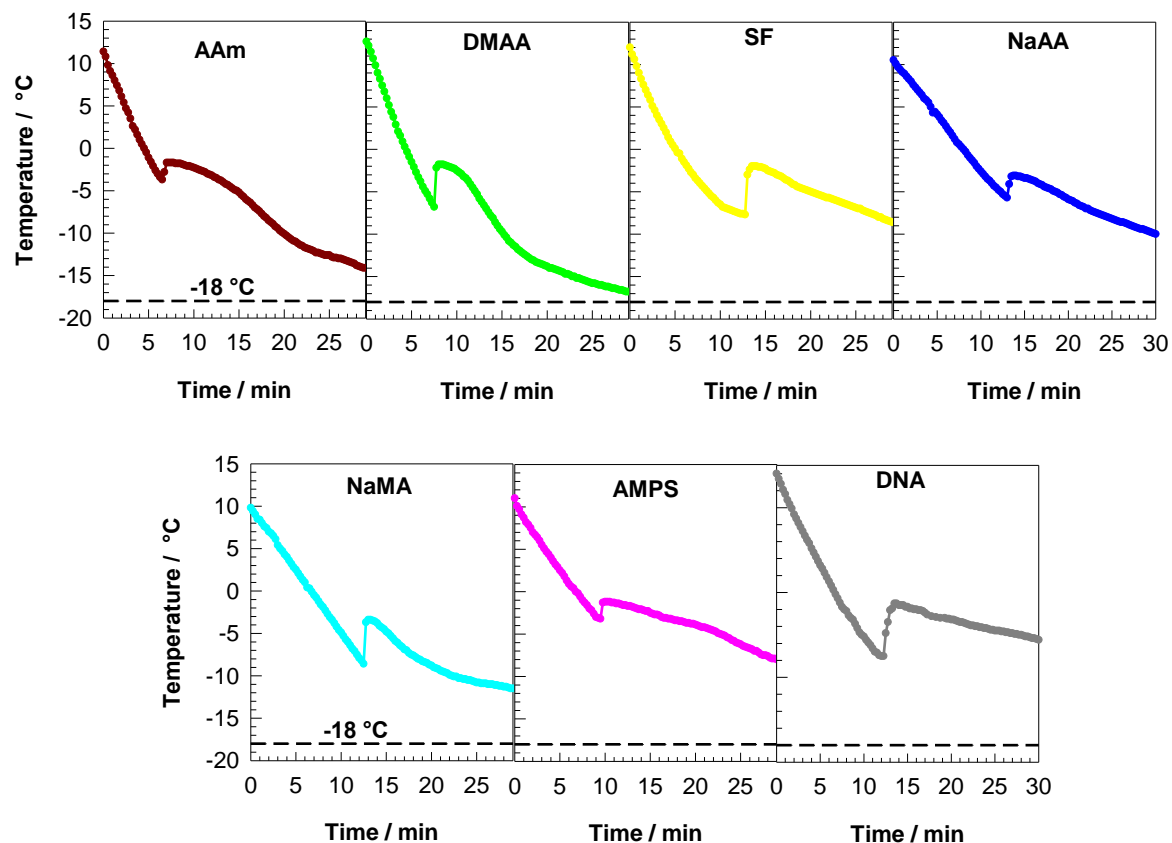


Figure S1. The cooling profiles of the aqueous monomer and polymer solutions in a freezer adjusted to $-18\text{ }^{\circ}\text{C}$. The types of the monomers and polymers are indicated. The rate of cooling during the first 5 min is $-2.0\pm 0.6\text{ }^{\circ}\text{C}\cdot\text{min}^{-1}$. The temperature of all solutions except DNA reduces to $-18\text{ }^{\circ}\text{C}$ within 60-90 min, while DNA solution needs 3h to attain the thermal equilibrium with the freezer.

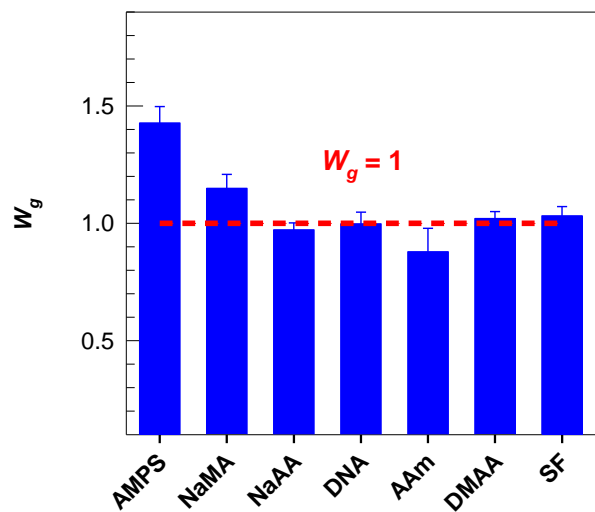
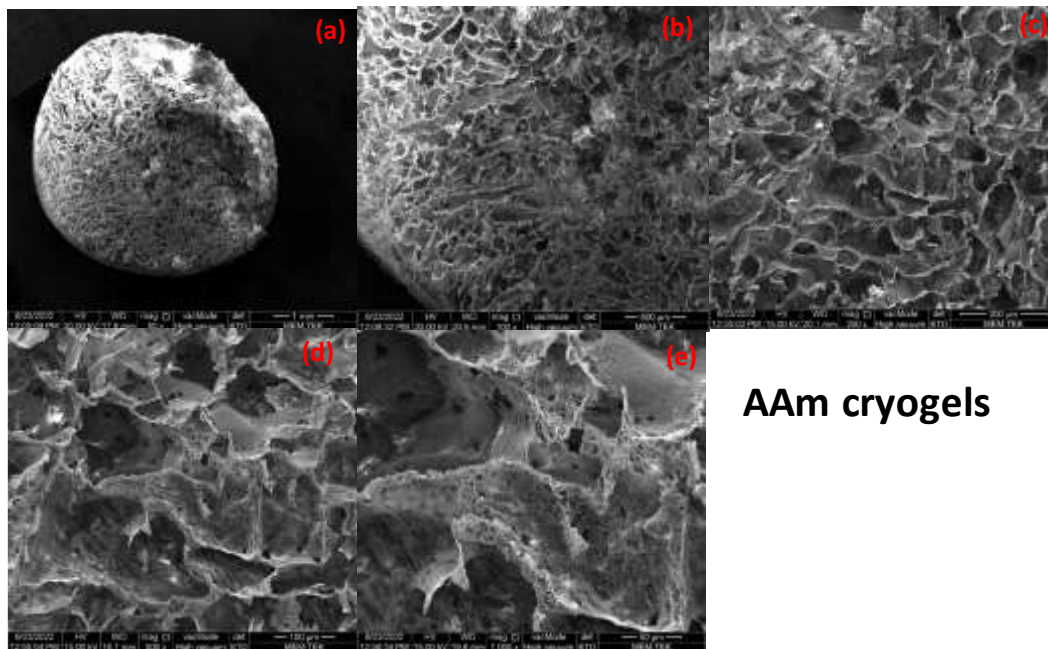
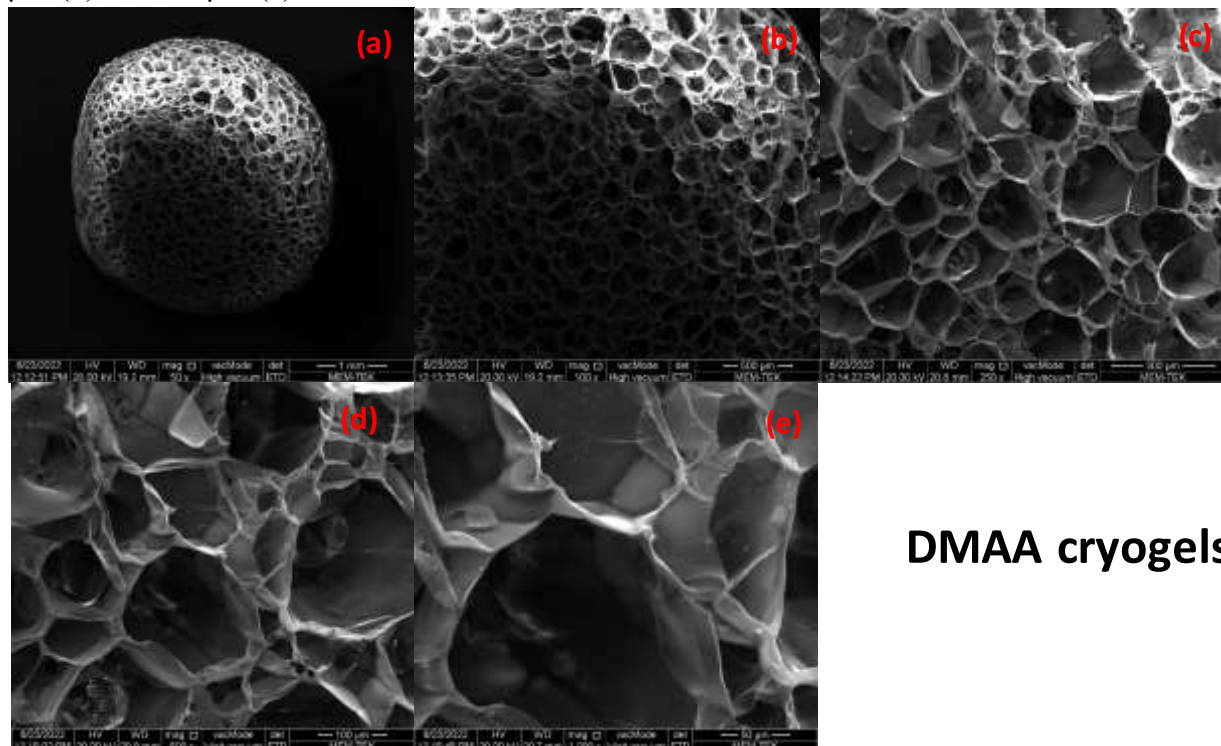


Figure S2. The gel fraction W_g of the cryogels. The dashed horizontal line represents complete gel fraction, e.g., $W_g = 1$.



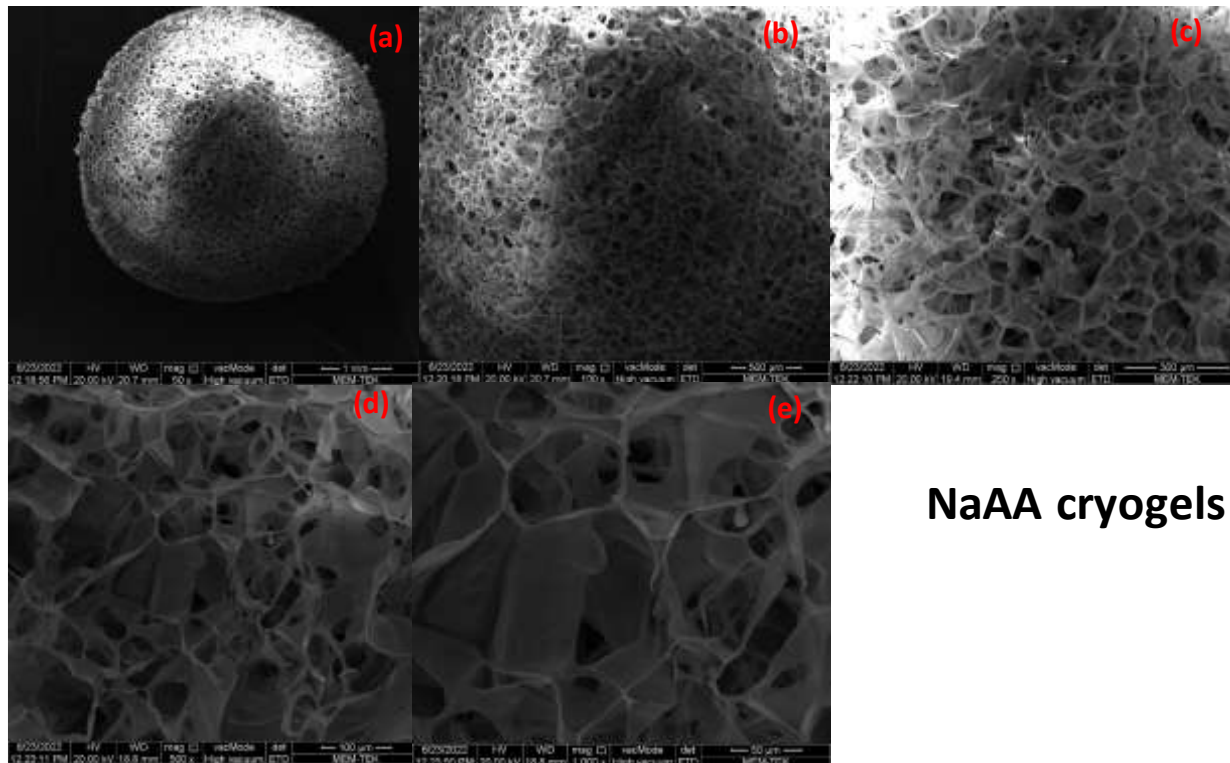
AAm cryogels

Figure S3a. SEM images of AAm cryogels. Scale bars: 1 mm (a), 500 μm (b), 300 μm (c), 100 μm (d), and 50 μm (e).



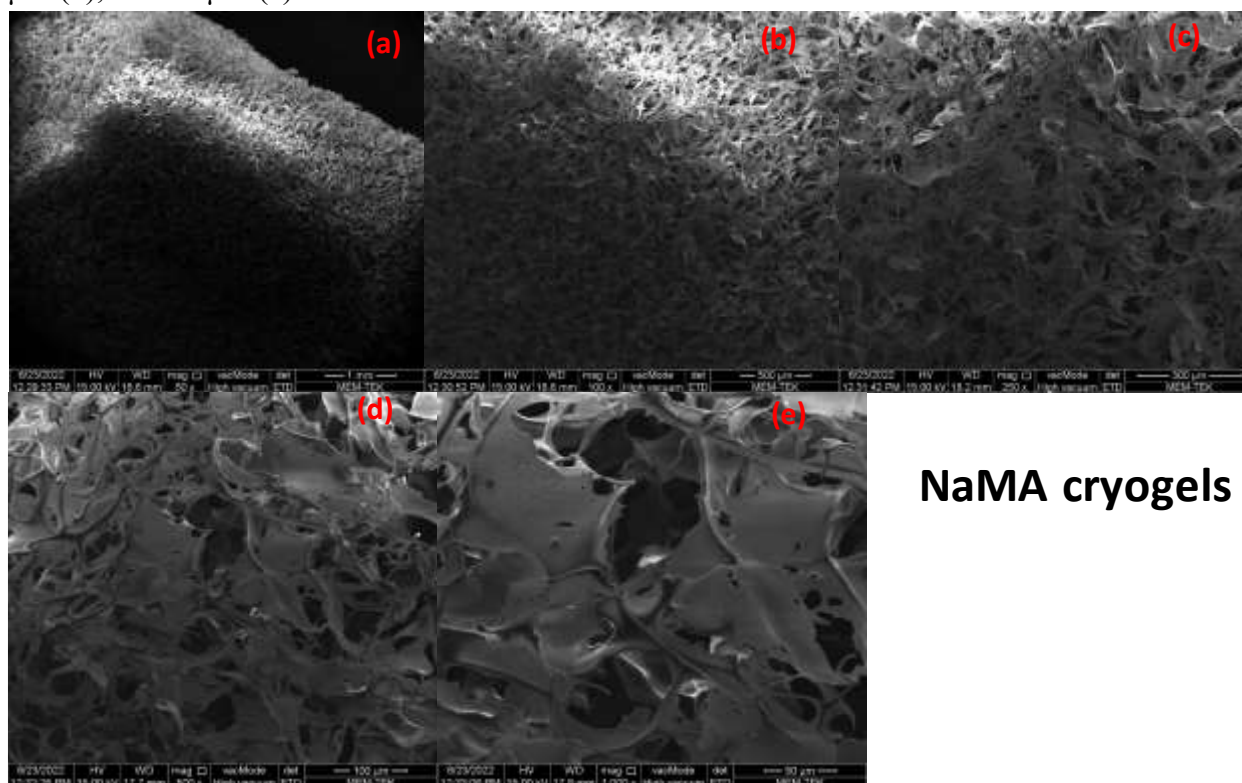
DMAA cryogels

Figure S3b. SEM images of DMAA cryogels. Scale bars: 1 mm (a), 500 μm (b), 300 μm (c), 100 μm (d), and 50 μm (e).



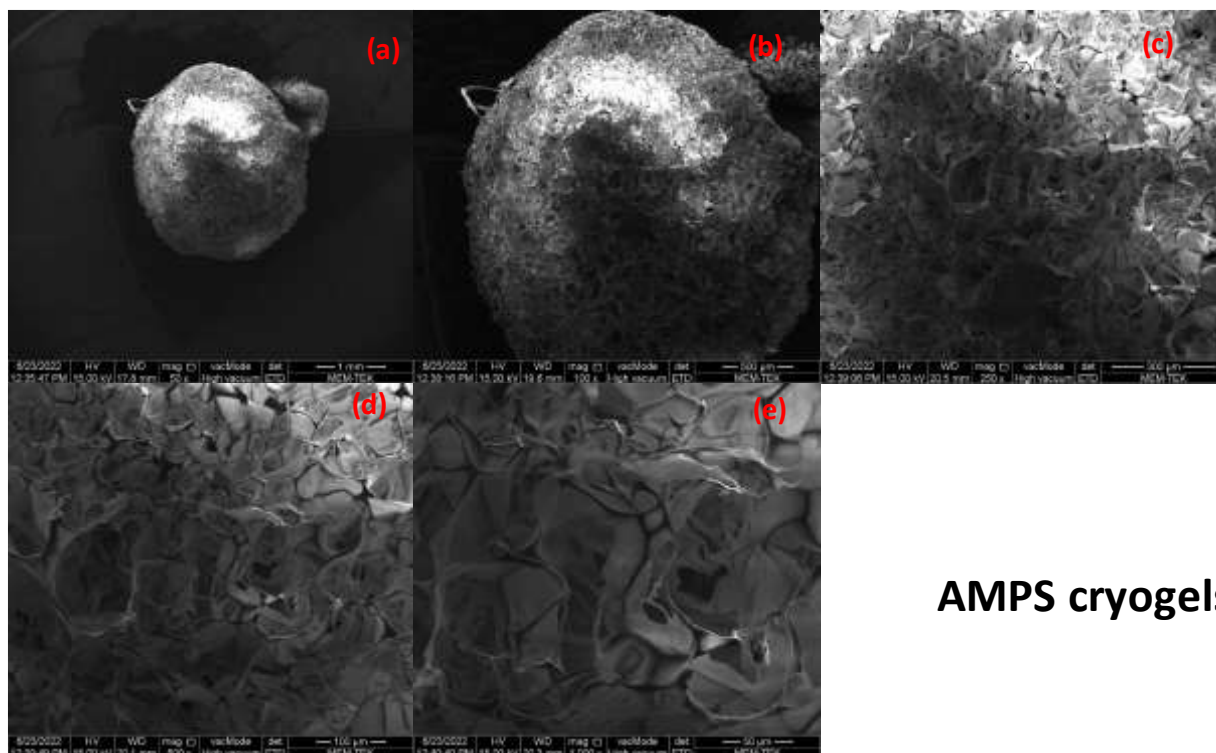
NaAA cryogels

Figure S3c. SEM images of NaAA cryogels. Scale bars: 1 mm (a), 500 μm (b), 300 μm (c), 100 μm (d), and 50 μm (e).



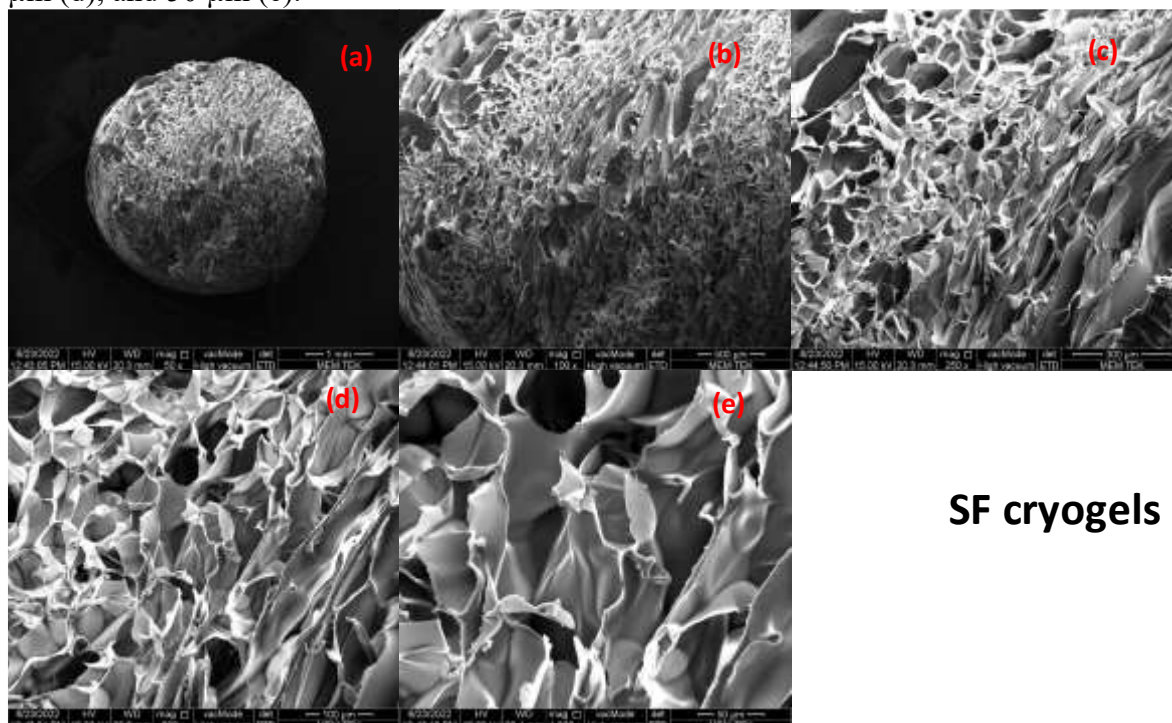
NaMA cryogels

Figure S3d. SEM images of NaMA cryogels. Scale bars: 1 mm (a), 500 μm (b), 300 μm (c), 100 μm (d), and 50 μm (e).



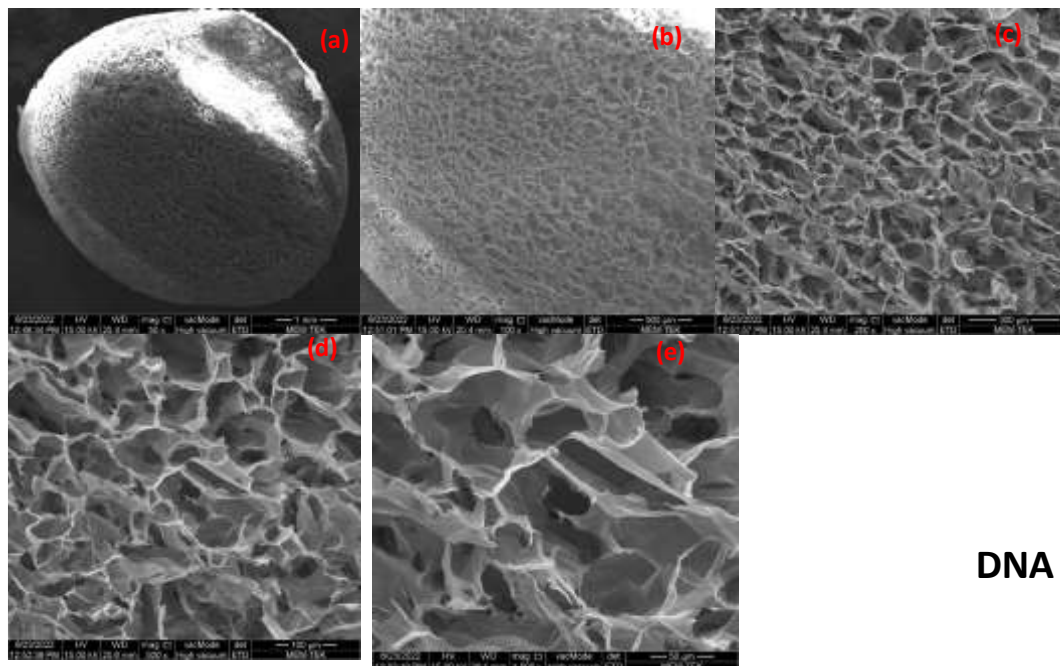
AMPS cryogels

Figure S3e. SEM images of AMPS cryogels. Scale bars: 1 mm (a), 500 μm (b), 300 μm (c), 100 μm (d), and 50 μm (e).



SF cryogels

Figure S3f. SEM images of SF cryogels. Scale bars: 1 mm (a), 500 μm (b), 300 μm (c), 100 μm (d), and 50 μm (e).



DNA cryogels

Figure S3g. SEM images of DNA cryogels. Scale bars: 1 mm (a), 500 μm (b), 300 μm (c), 100 μm (d), and 50 μm (e).

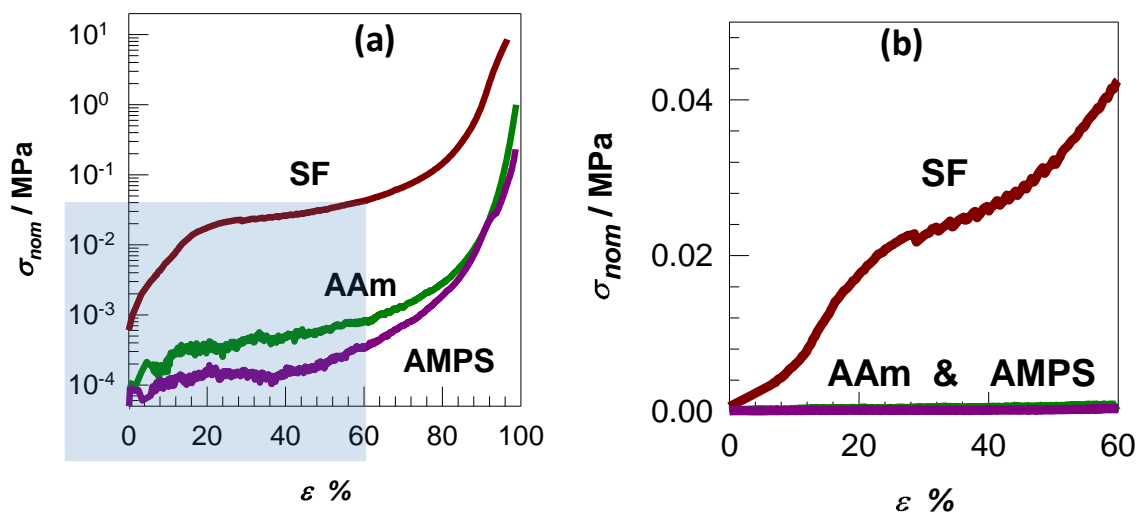


Figure S4. (a) The nominal stress plotted against the strain in a semi-logarithmic scale for equilibrium swollen SF, AAm, and AMPS cryogels in water. (b) Zoom-in to the blue area in (a) in linear scale.