

Fabrication of Eco-friendly Polyelectrolyte Membranes for Drug Delivery, Toxic Metal Ion Removal and Fuel Cell Applications

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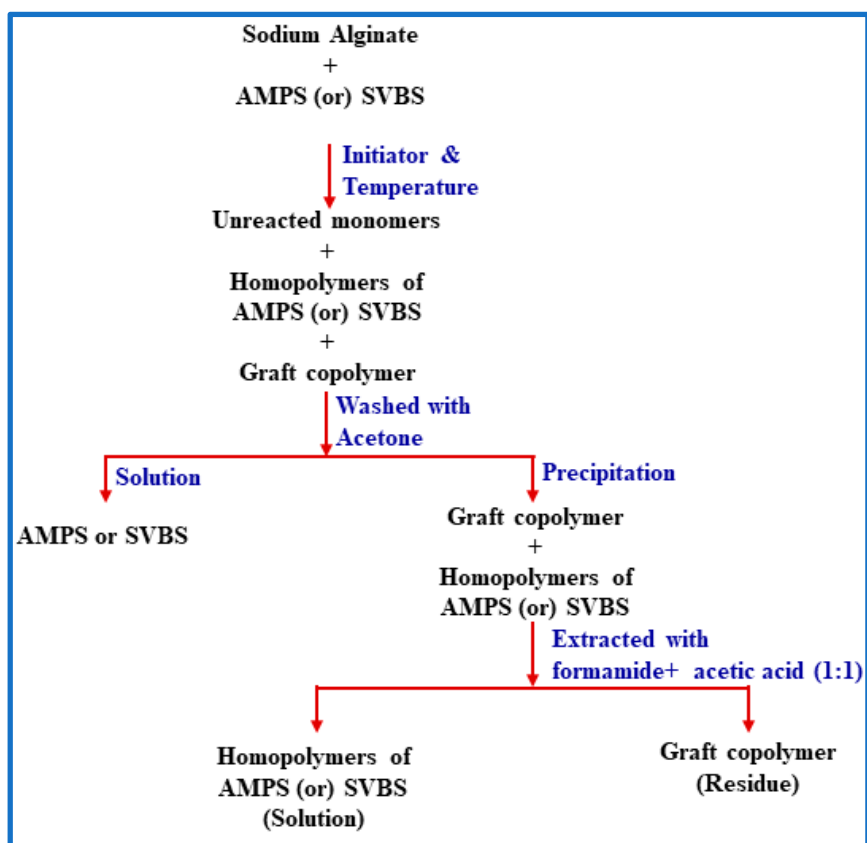
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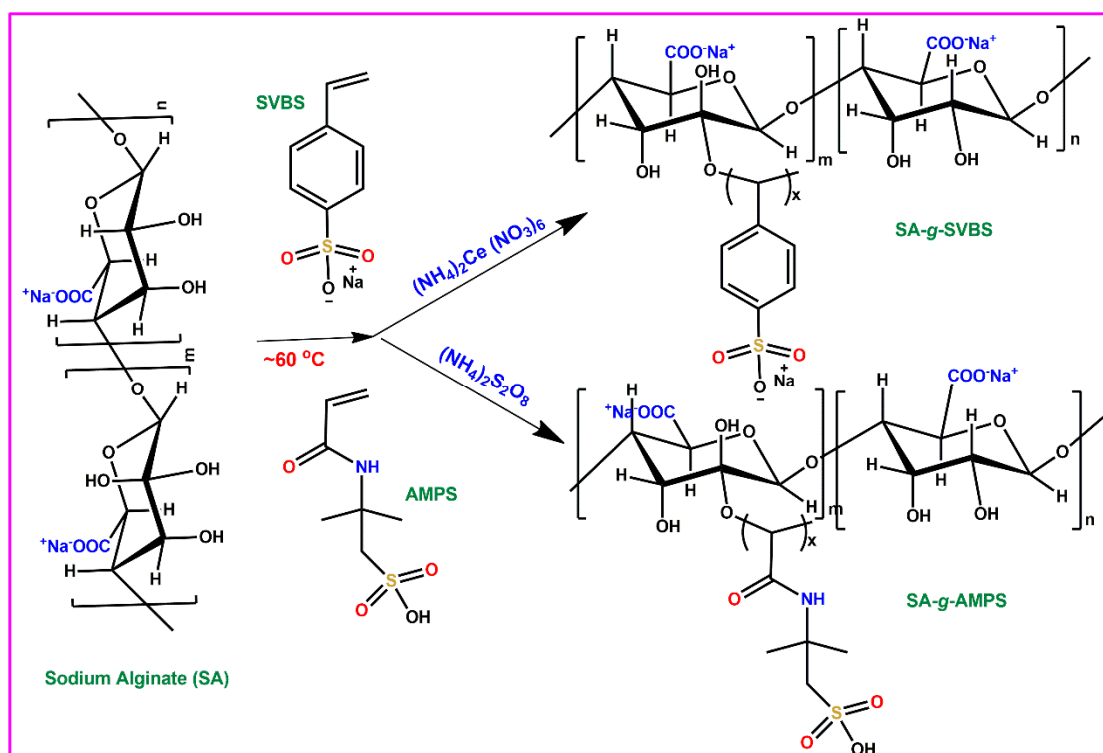
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Scheme S1: Flow chart of sulfonate graft SA copolymers preparation and purification.



Scheme S2: Plausible schemactic chemistry of graft copolymerisation of AMPS and SBVS on to SA.

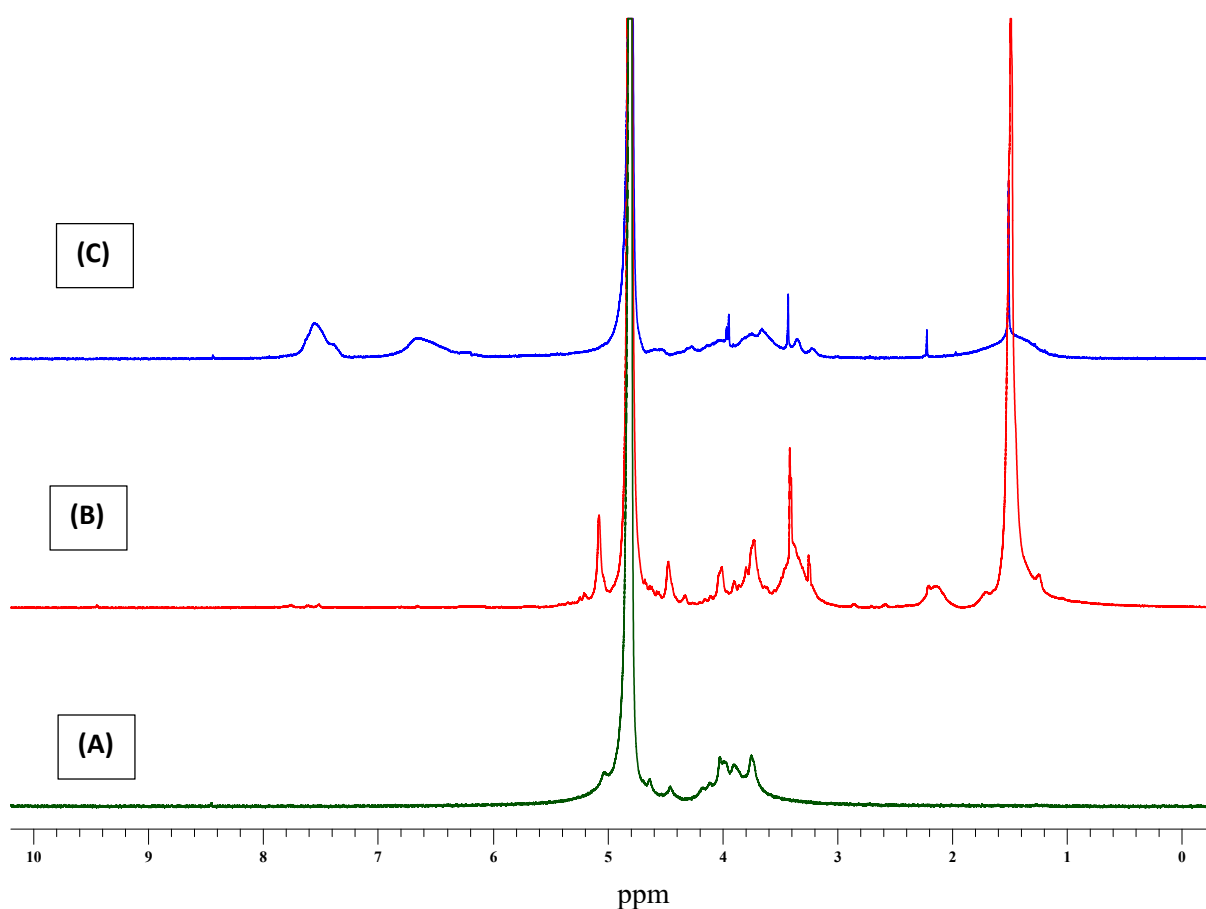


Figure S 1: NMR spectra of pure SA (A), SA-g-AMPS (B) and SA-g-SVBS (C).

NMR Studies.

The ^1H NMR spectrum of SA (in D_2O) shows peaks at $\delta = 5.28\text{--}4.57$ ppm, 4.45 ppm and 4.24–3.50 ppm. The presence of additional peaks at $\delta = 3.53\text{--}3.13$ ppm, 2.29–1.96 ppm and 1.80–1.14 ppm along with the SA backbone peaks at $\delta = 5.15\text{--}3.58$ ppm in the ^1H NMR spectrum of SA-g-AMPS (in D_2O) copolymer represents the AMPS incorporation on SA. Further, the formation of SA-g-SVBS has been confirmed by the presence of aromatic protons in its ^1H NMR spectrum (D_2O) at $\delta = 7.72\text{--}7.27$ ppm and 6.89–6.26 ppm along with the SA backbone peaks at $\delta = 5.10\text{--}3.13$ ppm.

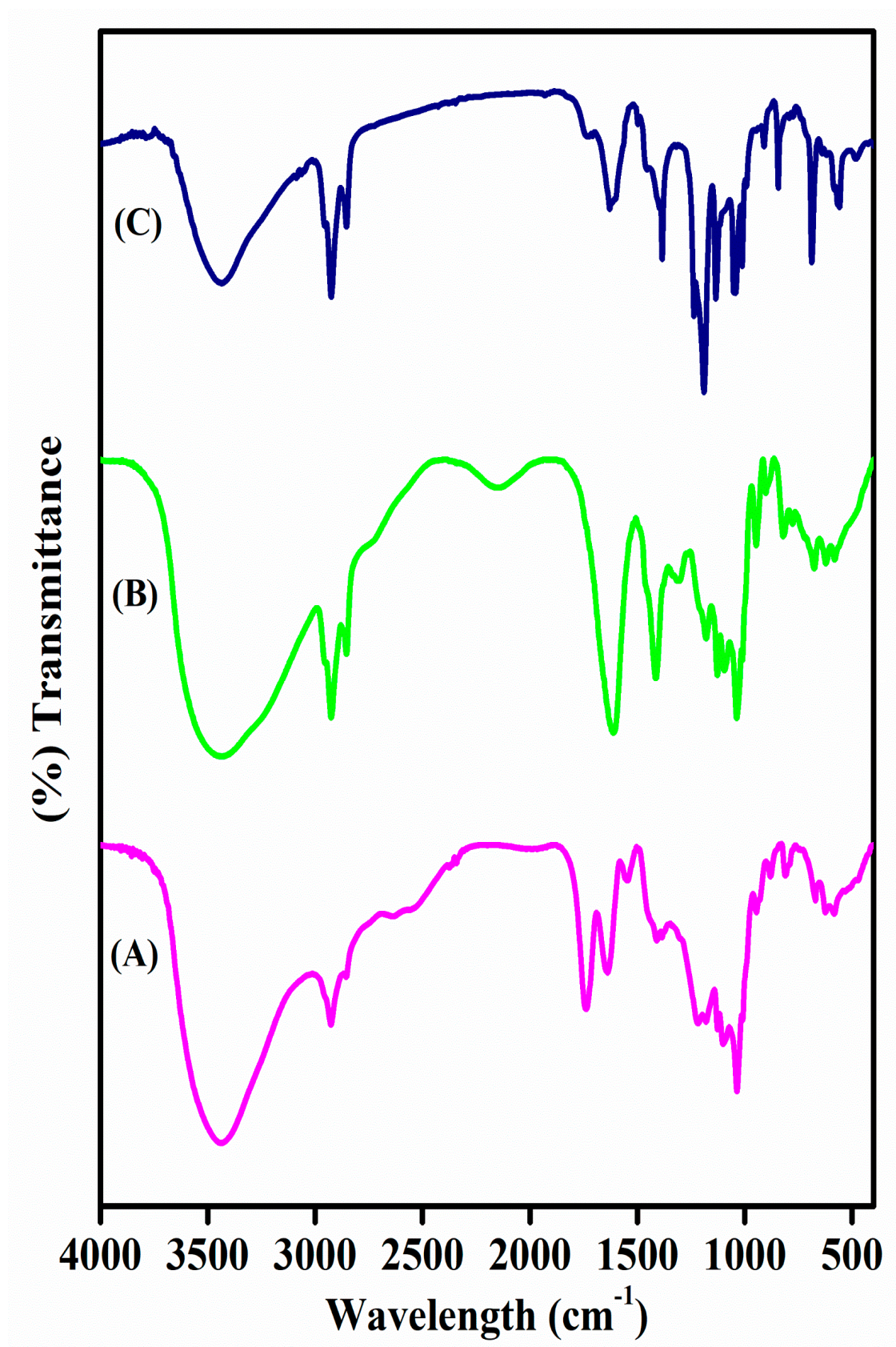


Figure S2: FTIR spectrum of pure SA (A), SA-g-AMPS (B) and SA-g-SVBS (C).

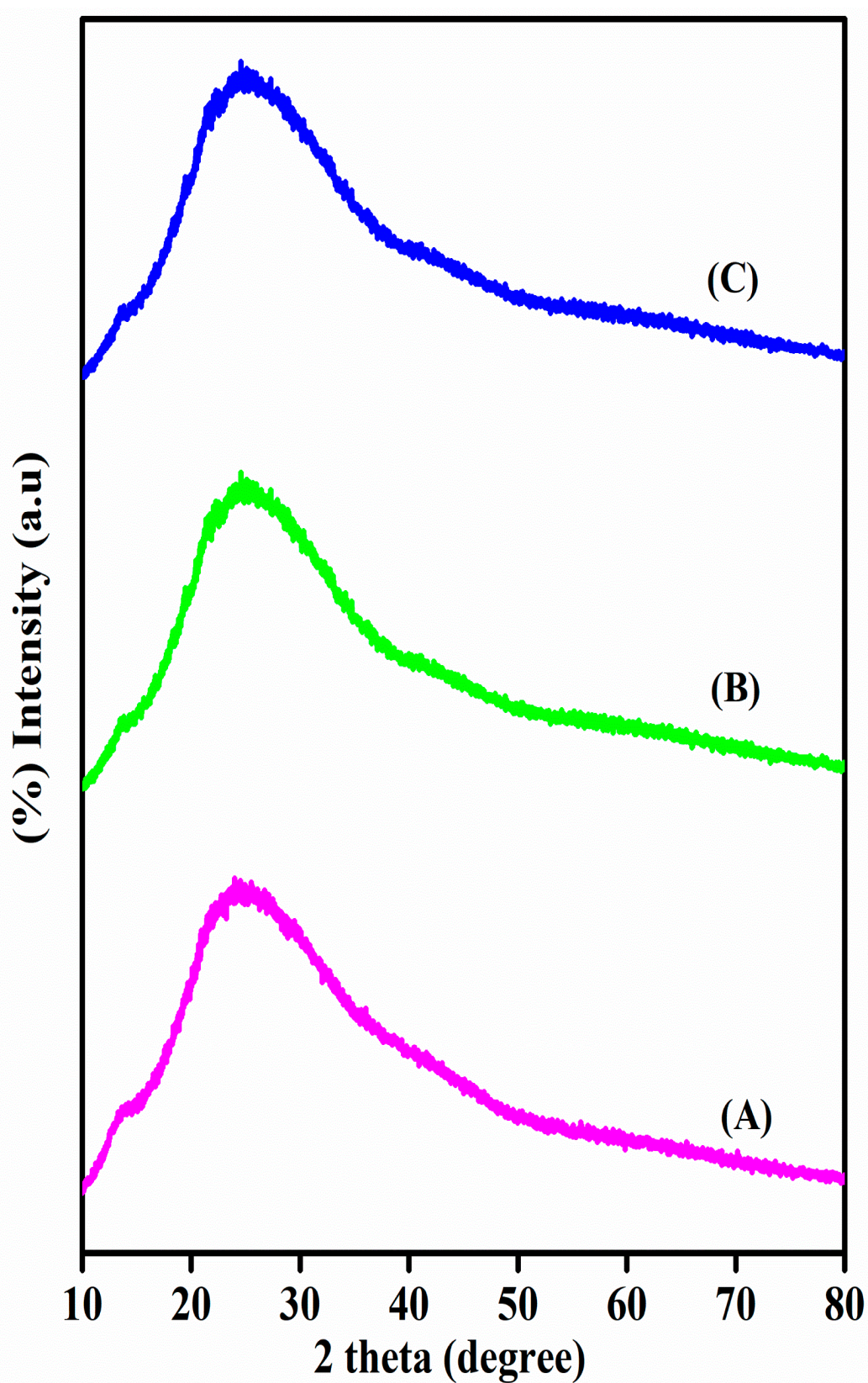


Figure S3: XRD patterns of pure SA (A), SA-g-AMPS (B) and SA-g-SVBS (C).

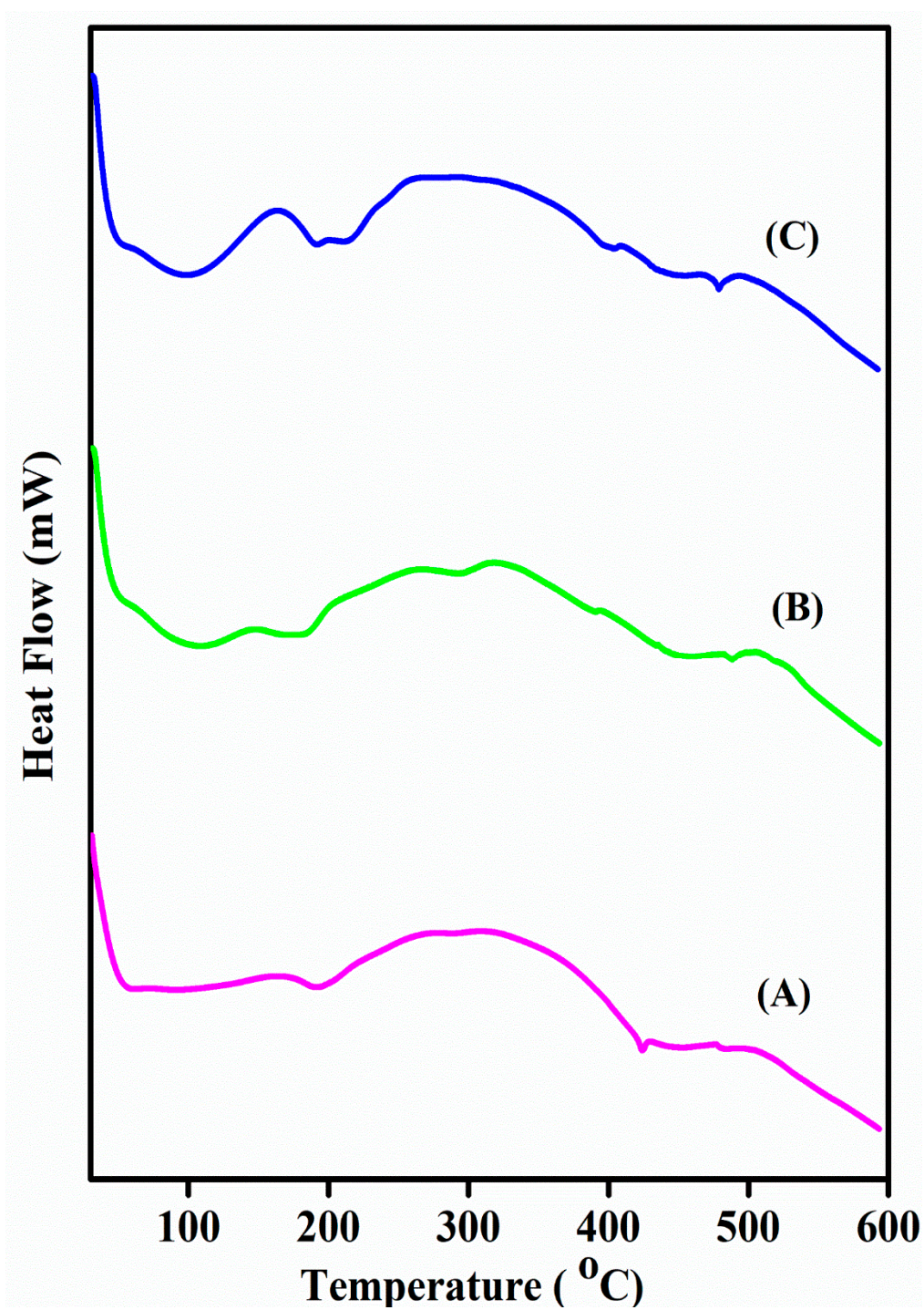


Figure S4: DSC of pure SA (A), SA-g-AMPS (B) and SA-g-SVBS (C).

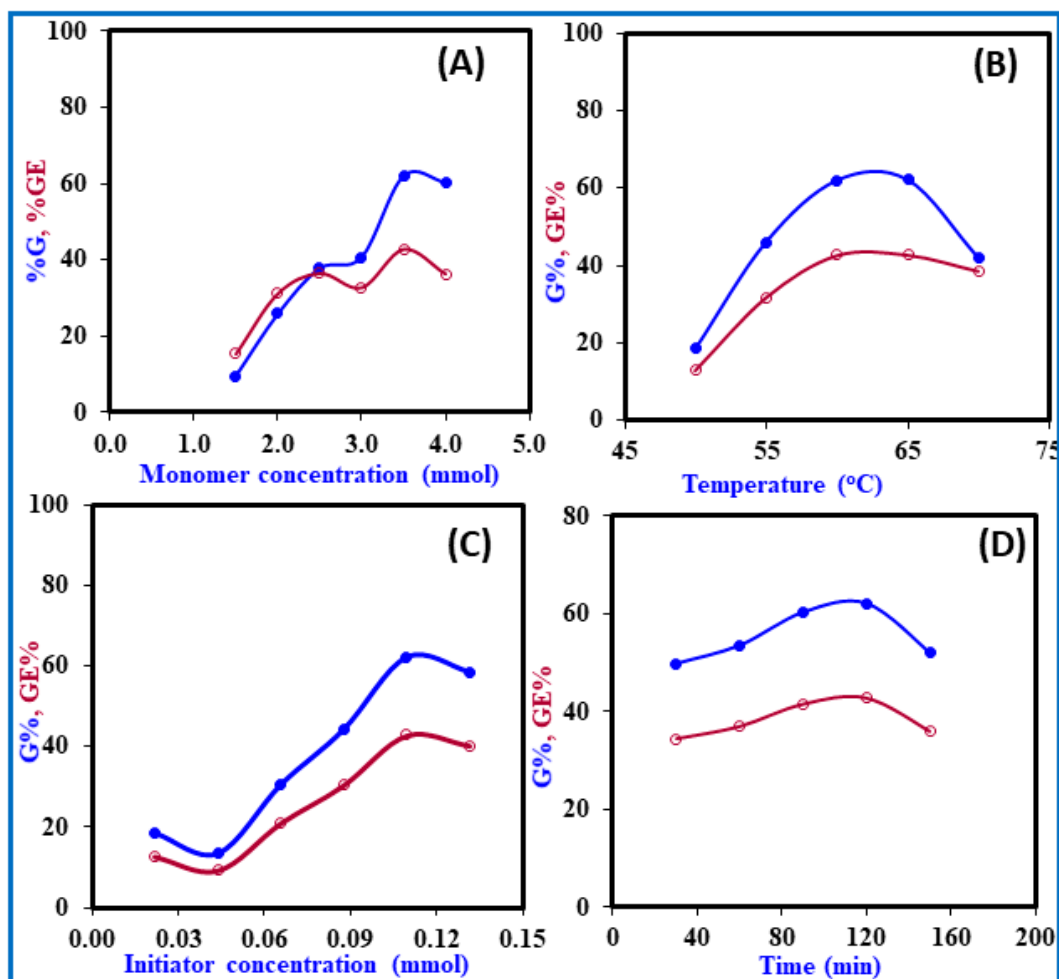


Figure S5: Effect of various reaction conditions on the grafting of AMPS onto the SA, prepared by APS as initiator. **(A)** Effect of monomer concentration [Other reaction conditions: 0.5 g of SA temperature: 60 °C; time: 120 min; initiator concentration 0.09mol.]. **(B)** Effect of reaction temperature [Other reaction conditions: 0.5 g of SA; Monomer concentration: 3.5 mmol; time: 120 min; initiator concentration 0.09 mol.] **(C)** Effect of initiator concentration [Other reaction conditions: 0.5 g of SA; Monomer concentration: 3.5 mmol; time: 120 min; temperature: 60 °C.] **(D)** Effect of reaction time. [Other reaction conditions: 0.5 g of SA; Monomer concentration: 3.5 mmol; initiator concentration 0.09 mol; temperature: 60 °C]

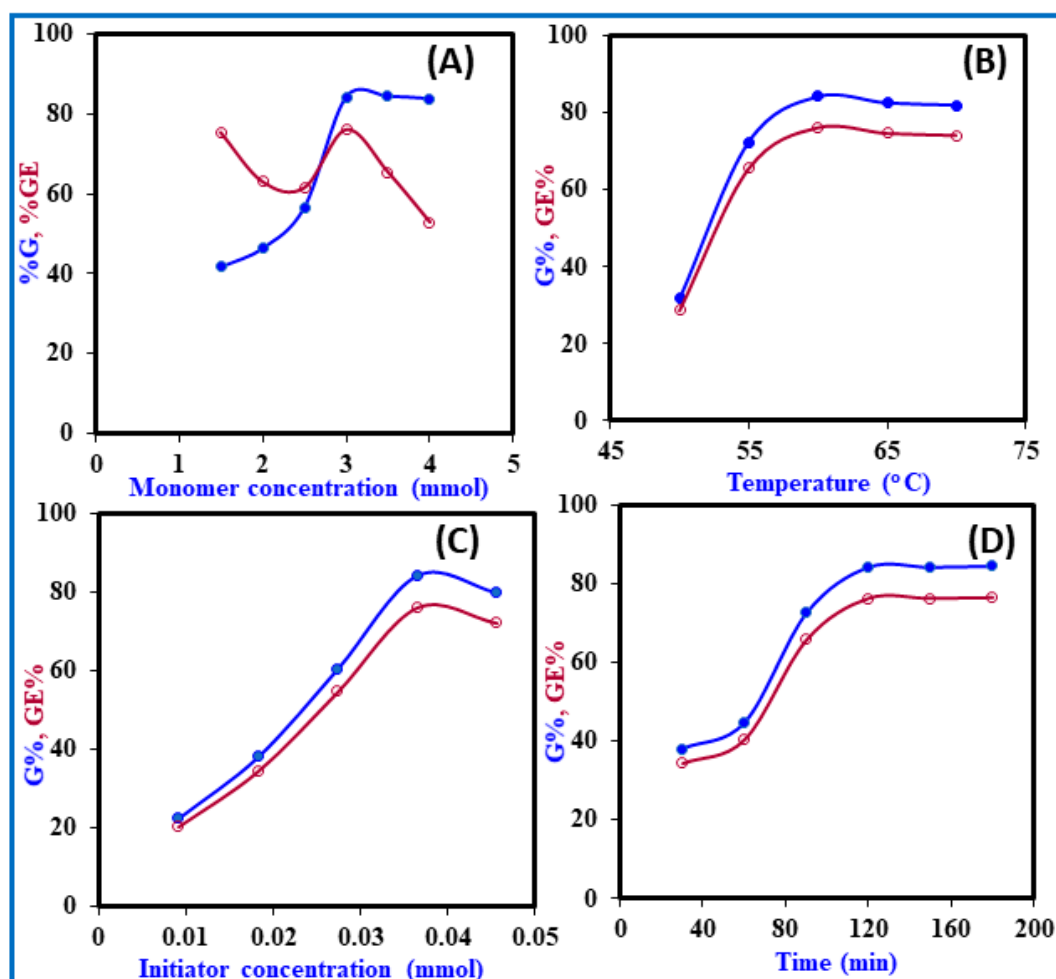


Figure S6: Effect of various reaction conditions on the grafting of SVBS onto the SA, prepared by CAN as initiator. **(A)** Effect of monomer (SVBS) concentration [Other reaction conditions: 0.5 g of SA; temperature: 60 °C; time: 120 min; initiator concentration 0.036 mmol.]. **(B)** Effect of reaction temperature [Other reaction conditions: 0.5 g of SA; Monomer concentration: 3.5 mmol; time: 120 min; initiator concentration 0.036 mmol.] **(C)** Effect of initiator concentration [Other reaction conditions: 0.5 g of SA; Monomer concentration: 3.5 mmol; time: 120 min; temperature: 60 °C.] **(D)** Effect of reaction time. [Other reaction conditions: 0.5 g of SA; Monomer concentration: 3.5 mmol; initiator concentration 0.036 mmol; temperature: 60 °C]



Figure S7: Digital photographs of various Sulfonated SA based PEMs.

Table S1: %Grafting, %grafting efficiency, %conversion, and %yield of PC-g-AMPS graft copolymer prepared by APS as initiator based on effect of various reaction conditions.

	%Grafting	%Grafting Efficiency	%Conversion	%Yield
Temperature (°C)	Effect of temperature on grafting			
50	18.60	12.82	81.76	48.40
55	46.02	31.72	100.66	59.59
60	61.86	42.64	111.58	66.05
65	62.06	42.78	111.72	66.13
70	42.02	28.97	97.90	57.95
Time (min)	Effect of time on grafting			
30	49.80	34.33	103.27	61.13
60	53.52	36.90	105.83	62.65
90	60.24	41.53	110.46	65.39
120	62.06	42.78	111.72	66.13
150	52.02	35.86	104.80	62.03
APS concentration (mmol)	Effect of initiator concentration on grafting			
0.02	18.46	12.73	81.66	48.34
0.04	13.40	9.24	78.17	46.27
0.06	30.46	21.00	89.94	53.24
0.07	44.16	30.44	99.38	58.83
0.09	62.06	42.78	111.72	66.13
0.11	58.40	40.26	109.20	64.64
AMPS concentration (mmol)	Effect of monomer concentration on grafting			
1.5	9.61	15.46	176.29	67.59
2.0	25.86	31.19	151.82	68.81
2.5	37.80	36.48	132.98	67.67
3.0	40.71	32.74	113.16	62.72
3.5	62.02	42.75	111.68	66.11
4.0	60.28	36.36	96.67	60.30

Table S2: %Grafting, %grafting efficiency, %conversion, and %yield of PC-g-SVBS graft copolymer prepared by CAN as initiator based on effect of various reaction conditions.

	%Grafting	%Grafting Efficiency	%Conversion	%Yield
Temperature (°C)	Effect of temperature on grafting			
50	31.86	28.83	119.30	62.63
55	72.46	65.56	156.04	81.92
60	84.22	76.20	166.68	87.50
65	82.60	74.73	165.21	86.74
70	82.02	74.21	164.69	86.46
Time (min)	Effect of time on grafting			
30	38.00	34.38	124.86	65.55
60	44.72	40.46	130.94	68.74
90	72.64	65.72	156.20	82.00
120	84.22	76.20	166.68	87.50
150	84.18	76.16	166.64	87.49
180	84.00	76.00	166.48	87.40
CAN concentration (mmol)	Effect of initiator concentration on grafting			
0.009	22.46	20.32	110.80	58.17
0.018	38.12	34.49	124.97	65.61
0.027	60.46	54.70	145.18	76.22
0.036	84.22	76.20	166.68	87.50
0.046	79.86	72.25	162.73	85.43
SVBS concentration (mmol)	Effect of monomer concentration on grafting			
1.5	41.71	75.48	256.43	91.27
2.0	46.42	63.00	198.71	84.30
2.5	56.62	61.47	170.05	81.53
3.0	84.22	76.20	166.68	87.50
3.5	84.38	65.44	142.99	80.53
4.0	83.78	56.80	124.65	74.26

Table-S3: Various kinetics model for 5FU release studies.

Sample code	Zero order		First order		Higuchi		Hixson-Crowell		Korsmeyer		
	R	K_0	R	K_1	R	K_h	R	K_{hc}	pH-1.2		
PVA	0.85	5.12	0.723	4.03	0.823	1.75	0.731	3.35	0.943	8.21	5.32
PSASB	0.954	0.681	0.989	1.35	0.991	0.58	0.995	1.44	0.995	2.22	0.309
PSAAM	0.977	1.133	0.990	1.00	0.990	0.43	0.966	1.22	0.993	0.217	0.865