

Electronic Supplementary Information

Tunable Doubly Responsive UCST-Type Phosphonium Poly(ionic liquid):

A Thermosensitive Dispersant for Carbon Nanotubes

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Table S1. Effect of NaCl concentration on the cloud point temperatures of P[VBTP][Cl]s of varying molecular weights at 0.5 wt% concentration during cooling cycle ($\lambda = 600$ nm).

Sample	Cloud point temperature (°C) at different NaCl concentration				
	475 mM	500 mM	525 mM	550 mM	575 mM
P[VBTP][Cl]-40K	38	49.8	63.6	75.6	88
P[VBTP][Cl]-25K	35	46	61.5	72.4	83.4
P[VBTP][Cl]-18K	27.8	37.6	54.2	67.6	77

Table S2. Effect of NaBr concentration on the cloud point temperatures of P[VBTP][Cl] at 0.5 wt% concentration during cooling cycle ($\lambda = 600$ nm).

Sample	Cloud point temperatures (°C) different NaBr concentration		
	20 mM	30 mM	40 mM
P[VBTP][Cl]-40K	45	59.3	77

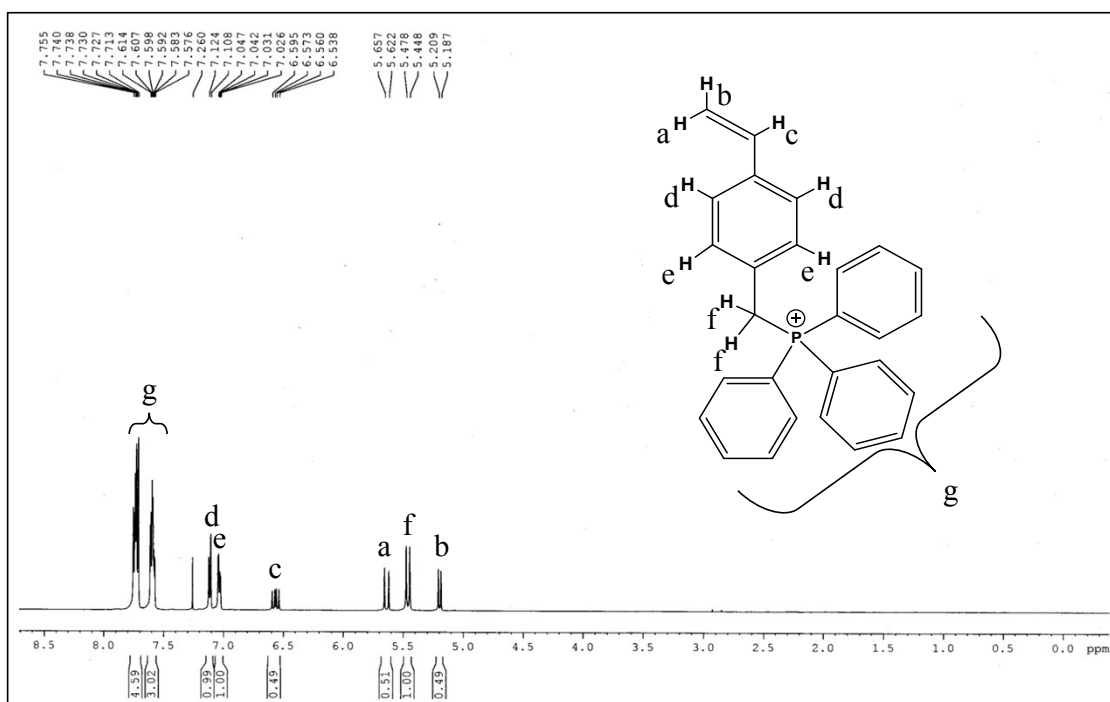


Figure S1. ^1H -NMR spectrum of the [VBTP][Cl] monomer (The ^1H -NMR peak at δ 7.26 ppm corresponds to CHCl_3 present in CDCl_3).

[VBTP][Cl]: ^1H -NMR (500 MHz, CDCl_3 , δ ppm): 5.2 (d, 1H, $J = 11$, vinyl proton trans to phenyl ring), 5.6 (d, 1H, $J = 17.5$, vinyl proton cis to phenyl ring), 6.5 (dd, 1H, vinyl proton germinal to phenyl ring), 5.46 (d, 2H, benzylic proton), 7.1 (m, 2H, ring proton of VBC far from phosphonium cation), 7.0 (m, 2H, ring proton of VBC close to phosphonium cation), 7.57-7.75 (m, 15H, phenyl ring protons of TPP).

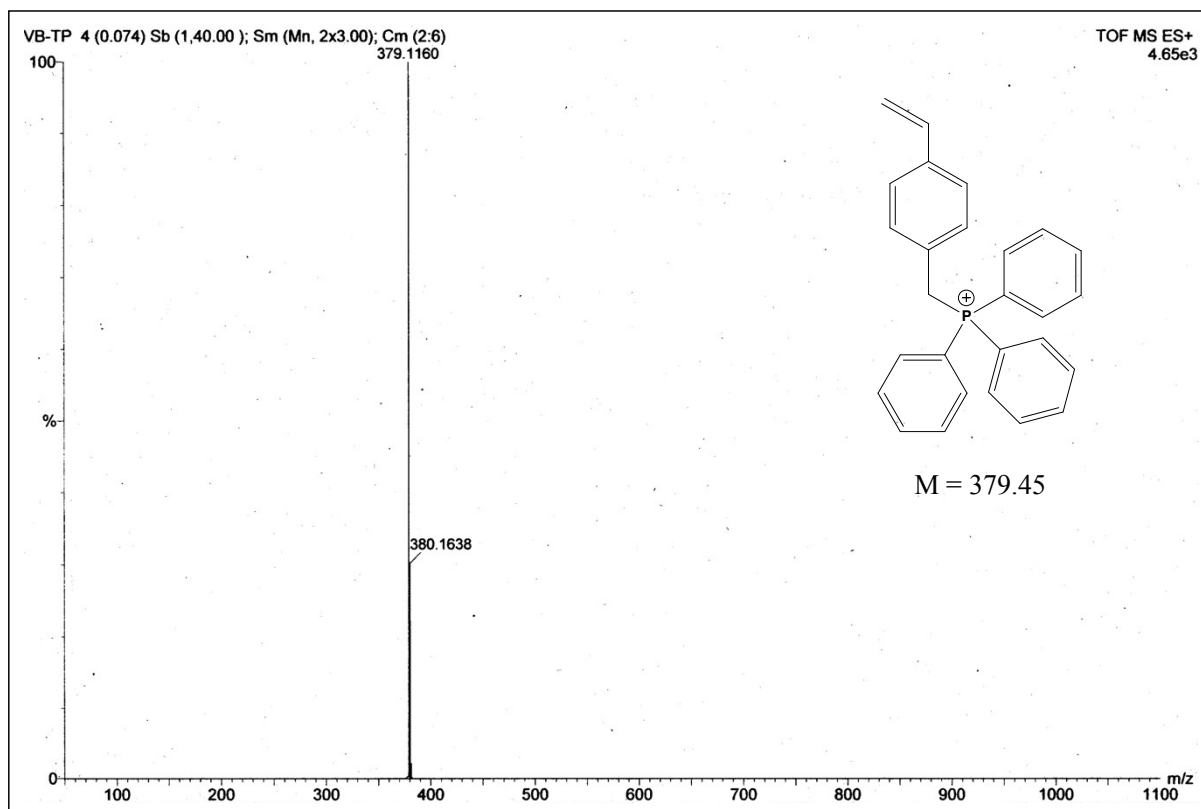


Figure S2. ESI mass spectrum of the [VBTP][Cl] monomer.

[VBTP][Cl]: MS (ESI) (35 eV): $m/z = 379.11$ g/mol.

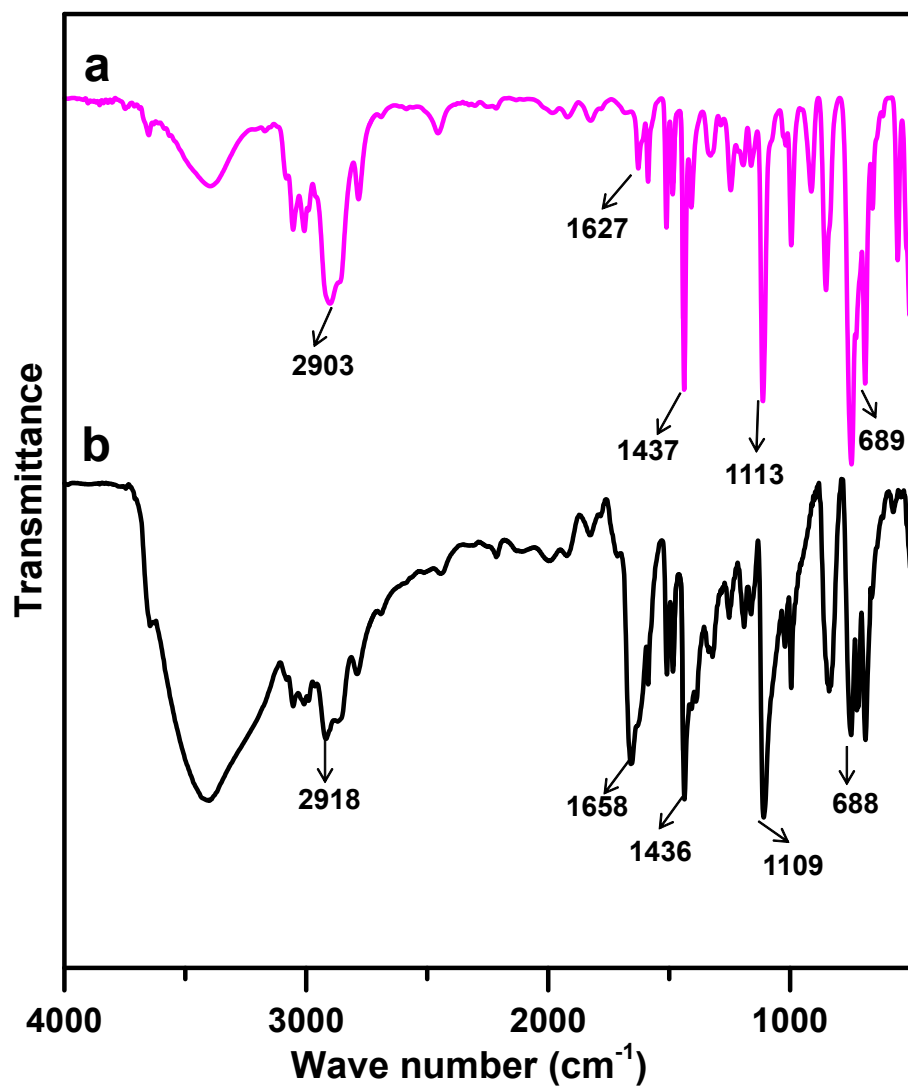


Figure S3. FTIR spectra of (a) [VBTP][Cl] monomer and (b) P[VBTP][Cl]-40K.

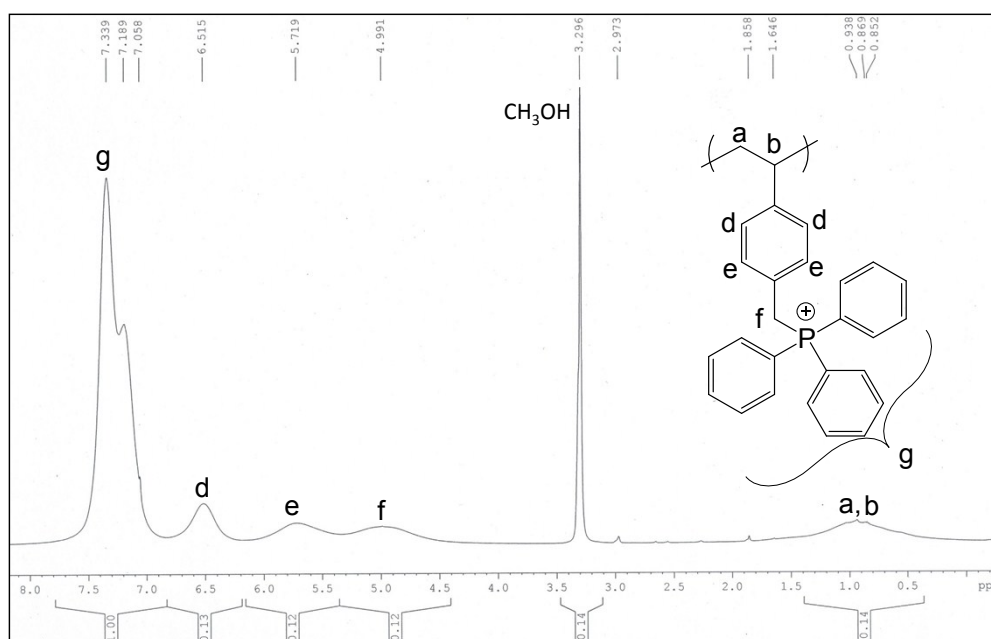


Figure S4. ^1H -NMR spectrum of the P[VBTP][Cl]-40K PIL.

^1H -NMR (500 MHz, $\text{CDCl}_3 - \text{CD}_3\text{OD}$ (10:1), δ ppm): 0.93-0.85 ($-\text{CH}_2$ and $-\text{CH}$ of polymer backbone, position 'a', 'b'); 4.99 (benzylic protons); 5.72 (ring protons of VBC close to phosphonium cation); 6.51 (ring protons of VBC close to phosphonium cation); 7.0-7.3 (phenyl ring protons of TPP unit).

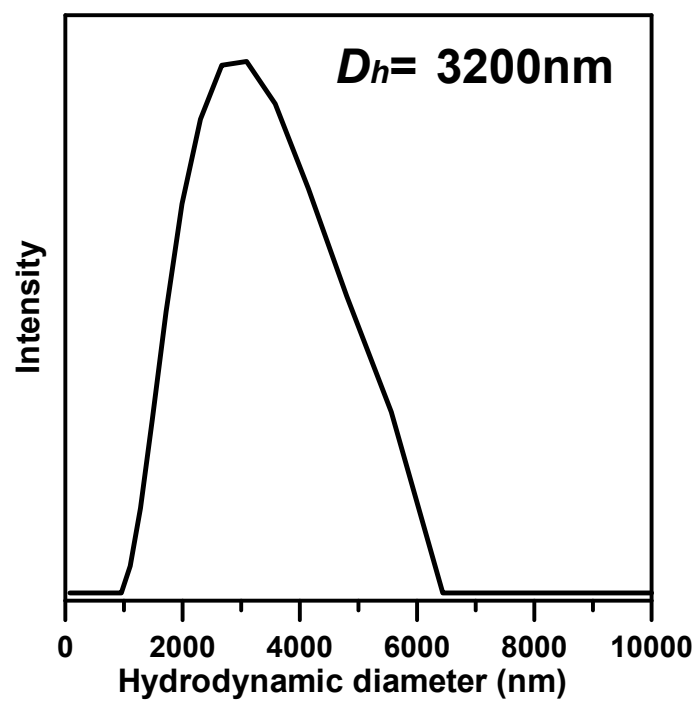


Figure S5. DLS curve of aqueous P[VBTP][Cl]-40K solution with 475 mM NaCl at 25 °C.

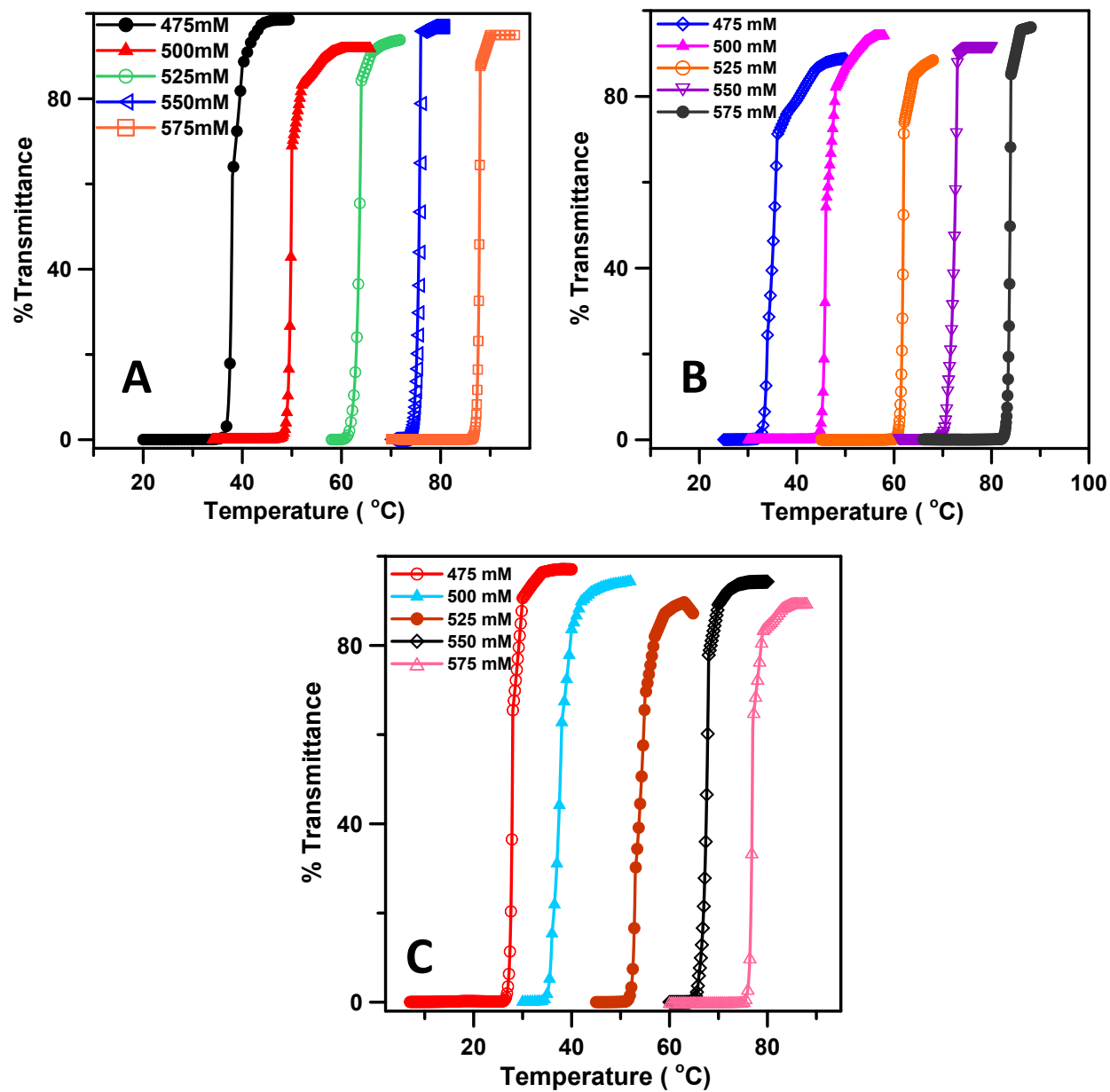


Figure S6. Transmittance curves (in the cooling cycle) of 0.5 wt% aqueous solution of (A) P[VBTP][Cl]-40K, (B) P[VBTP][Cl]-25K, (C) P[VBTP][Cl]-18K at different NaCl concentrations.

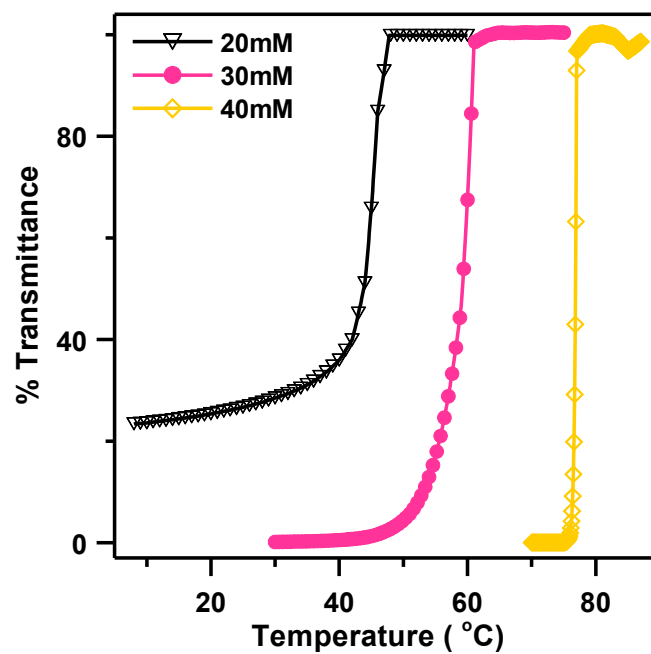


Figure S7. Transmittance curves (in the cooling cycle) of 0.5 wt% aqueous solution of P[VBTP][Cl]-40K at different NaBr concentration.

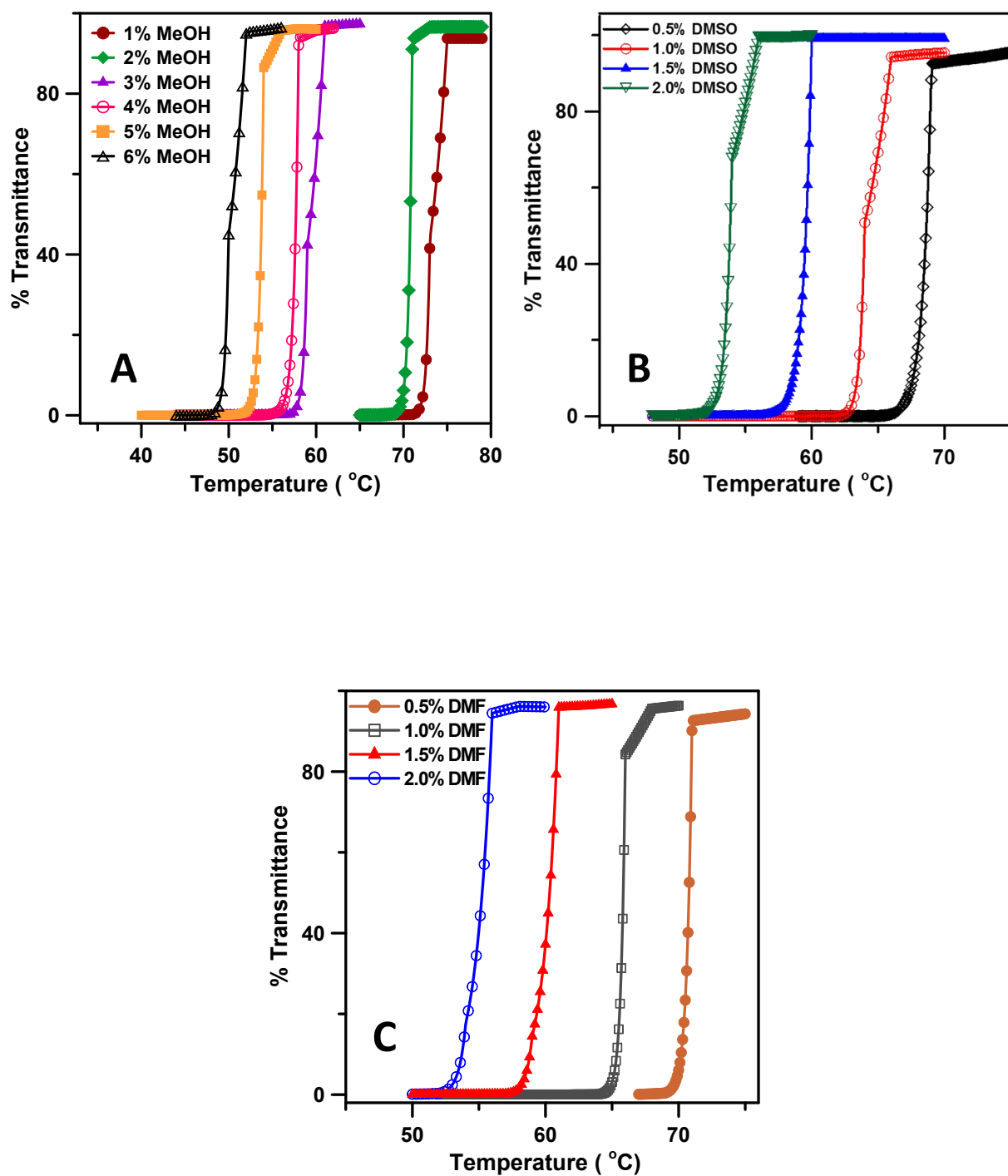


Figure S8. Transmittance cooling curves of 0.5 wt% P[VBTP][Cl]-40K solution containing 550 mM NaCl (A) in binary (water-MeOH) mixture at different volume % of

MeOH; (B) in water-DMSO mixture at different volume% of DMSO; (C) in water-DMF mixture at different volume % of DMF.

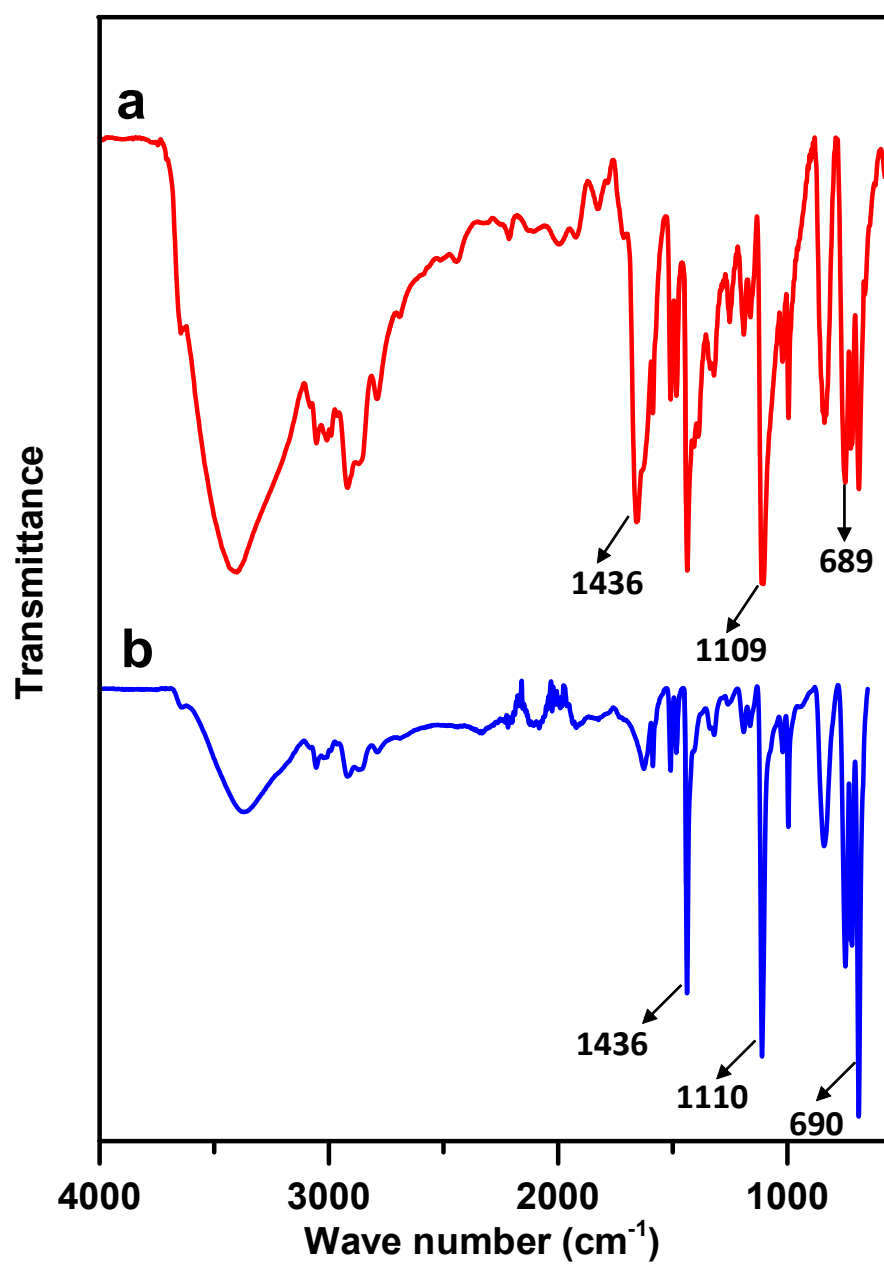


Figure S9. FTIR spectra of (a) P[VBTP][Cl]-40K and (b) P[VBTP][Cl]-40K-MWCNTs composite.