Electronic Supplementary Information

Aqueous dispersion of pristine single-walled carbon nanotubes prepared by using vinylimidazole-based polymer dispersant

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1. Polymer characterization

^{1}H-NMR (500 MHz, D_2O/DMSO-*d6*) spectra were recorded on a Bruker AV 500 spectrometer in Fourier transform mode. FTIR spectra were collected by using a Bruker VERTEX 70 spectrometer operated in an attenuated total reflectance mode. Elemental analysis was carried out using an Elementar Vario el Cube analyzer, and each reported data point is an average of three parallel measurements.

2. Synthesis of poly(1-vinylimidazole) (P1)

Into a 150 ml two-neck flask equipped with a water jacketed condenser, 60 ml of toluene, 5.0 g of 1-vinylimidazole and 0.10g of AIBN were added in sequence. The mixture was then stirred and heated to 70 °C under an N_2 atmosphere. After the reaction was sustained for 20 h, **P1** was precipitated from toluene, collected by filtration over a 0.2 μm poly(tetrafluoroethylene) (PTFE) membrane, washed thoroughly with toluene, and vacuum-dried at 50 ^oC for 12 h. The FTIR and ^{1}H-NMR spectra of **P1** are given in Fig. S1.

FTIR (ν, cm^{-1}): =C-H, 3104; C-H in $-CH_2-$, 2931; C=N, 1645; C-N, 1493.

^{1}H-NMR (δ, ppm) (D_2O): 7.17-6.43, ***a***; 3.62-2.45, ***b***; 1.97-1.85, ***c***.

$\overline{M_v}$ of **P1** was measured to be 27.2 kDa by using a dilute solution viscometry. 0.1 M of aqueous NaCl was used as the solvent of P1. The measurement was conducted at 25 ^oC and $\overline{M_v}$ was calculated using the equation of $[\eta] = 0.122 \times \overline{M_v}^{0.51}$.

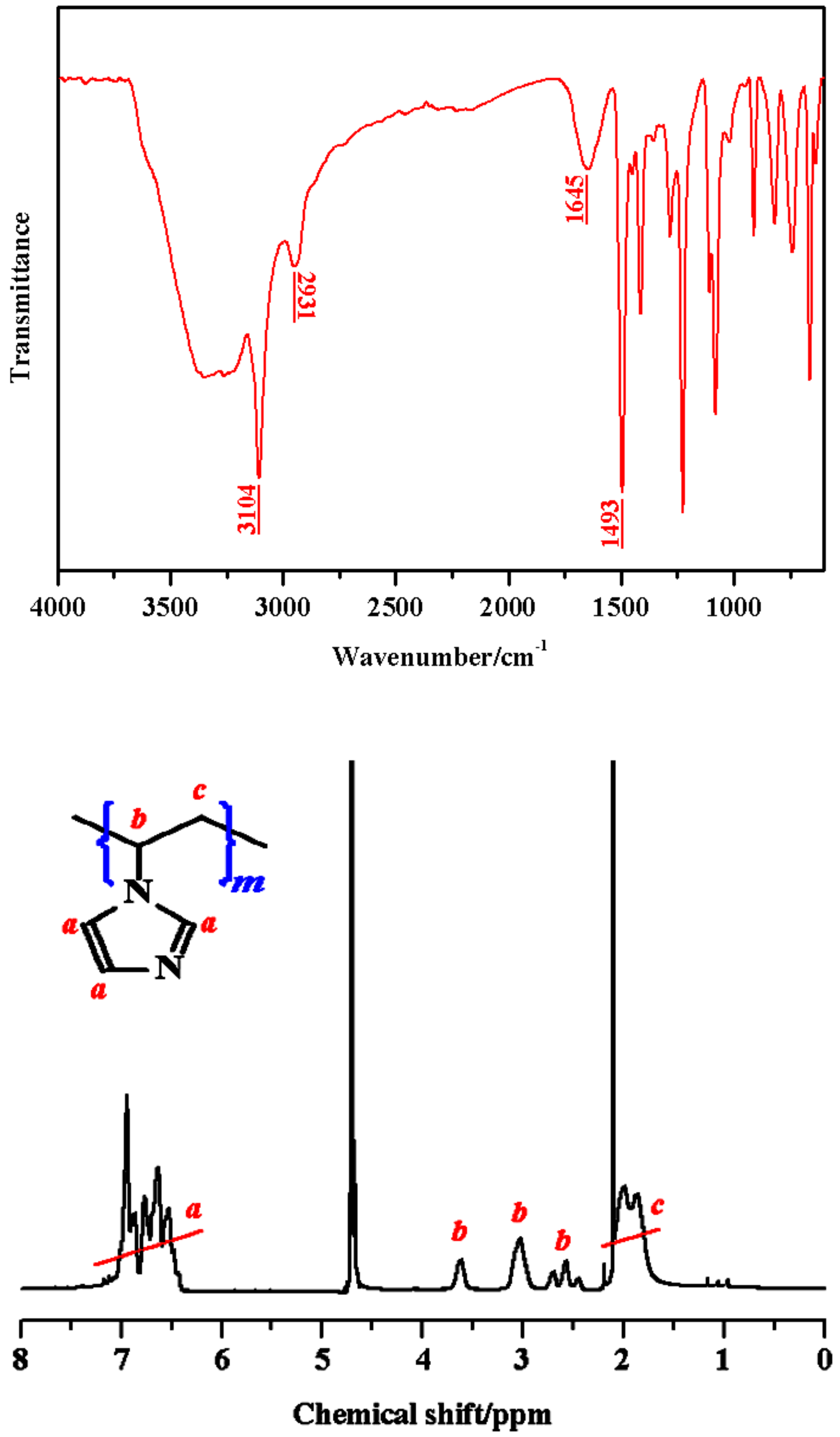

Fig. S1 FTIR (top) and ^{1}H-NMR (down) spectra of **P1**.

3. Synthesis of poly(1-vinyl-3-butylimidazolium chloride-*co*-1-vinylimidazole) (35/65) (P2)

2.1 ml (19.9 mmol) of 1-chlorobutane was added dropwise into a solution of **P1** (960 mg, 10.2 mmol of vinylimidazole unit) in 20 ml anhydrous ethanol at room temperature under an N_2 atmosphere. The reaction was subsequently performed for 24 h at 70 ^{o}C. After cooling to room temperature, the brown solution was poured into 80 ml of stirred ethyl acetate. The precipitate was separated by filtration through a 0.2 μm PTFE membrane, washed thoroughly with ethyl acetate, and vacuum-dried at 50 ^{o}C for 12 h to give the final product of **P2**. Fig. S2 shows the FTIR and 1H-NMR spectra of **P2**.

FTIR (ν, cm^{-1}): =C-H, 3105; C-H in $-CH_3$, 2959 and 2872; C-H in $-CH_2-$, 2934; C=N, 1648; C-N, 1496.

^{1}H-NMR (δ, ppm) (D_2O): 7.17-6.55, ***a***; 4.02-3.81, ***b***; 3.64-2.44, ***c***; 2.01-1.86, ***d***; 1.56-0.97, ***e*** and ***f***; 0.79, ***g***.

Further analysis of the ^{1}H-NMR spectrum showed that the integration ratio of the imidazole protons (7.17-6.55 ppm) to the methyl protons (0.79 ppm) was 0.347, indicating that the molar ratio of the 1-vinyl-3-butylimidazolium chloride unit to the 1-vinylimidazole unit in **P2** is round 35:65.

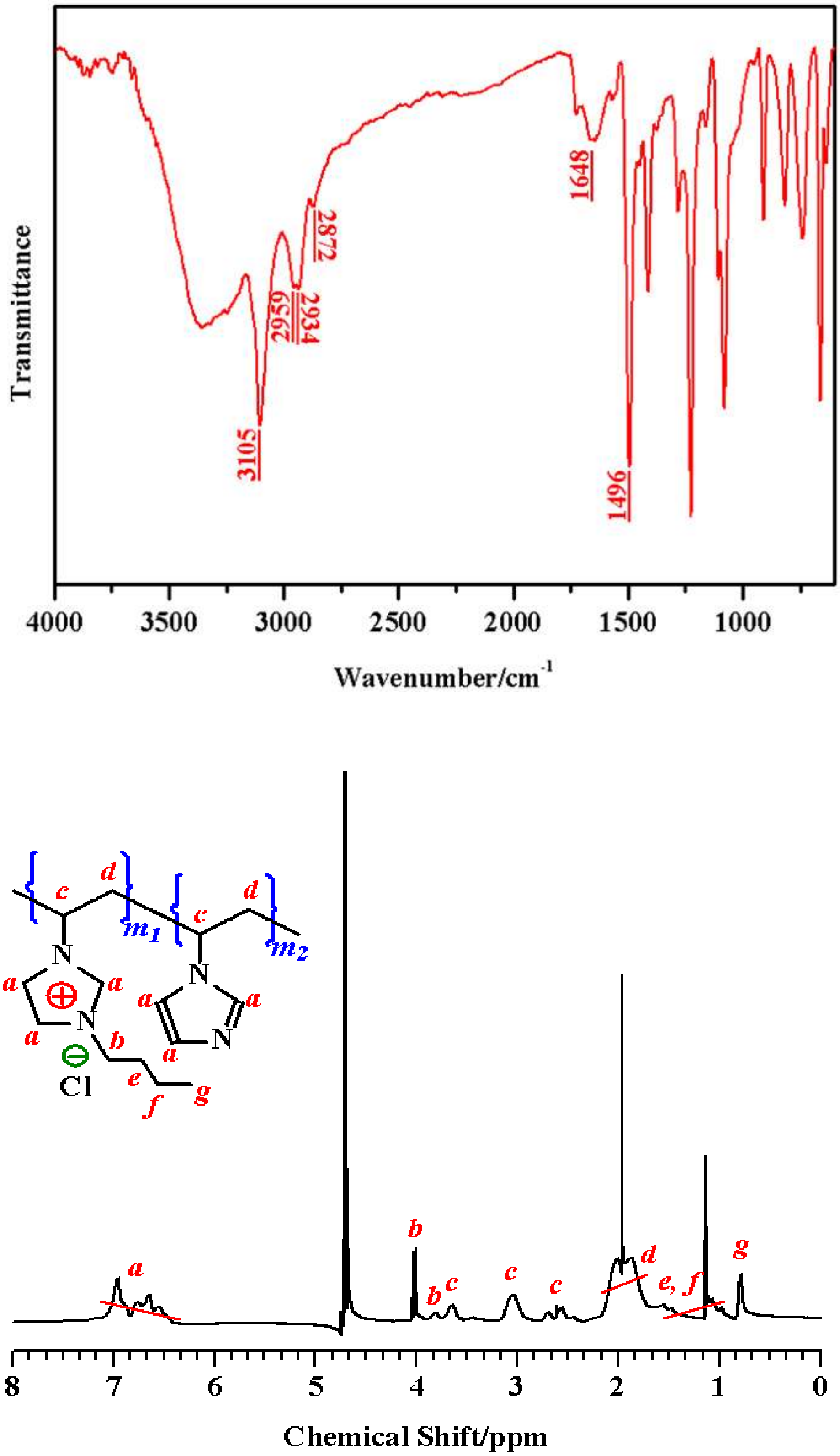

Fig. S2 FTIR (top) and ^{1}H-NMR (down) spectra of **P2**.

4. Synthesis of poly(1-vinylimidazole-*co*-PyMMA) (97/3) (P3)

Into a 50 ml two-neck flask equipped with a water jacketed condenser, 7.5 ml of dimethylformamide (DMF), 4.0712 g (43.3 mmol) of 1-vinylimidazole, 0.1314 g (0.44 mmol) of PyMMA, and 84 mg of AIBN were added in sequence. The mixture was then stirred and heated to 70 °C under an N_2 atmosphere. After the reaction was sustained for 20 h, the liquid solution was poured into 30 ml of ethyl acetate. The precipitated solid was collected by filtration over a 0.2 μm PTFE membrane, washed thoroughly with tetrahydrofuran (THF), and vacuum-dried at 60 ^{o}C for 12 h to give the final product of **P3**. Its FTIR and ^{1}H-NMR spectra are shown in Fig. S3.

FTIR (ν, cm^{-1}): =C-H, 3110; C-H in -CH_2-, 2932; C=O, 1763; C=N, 1658; C-N, 1495; C-O-C, 1223.

^{1}H-NMR (δ, ppm) (DMSO-d_6): 8.46-7.92, ***a***; 7.56-6.55, ***b***; 5.42, ***c***; 3.19-2.76, ***d***; 2.24-1.59, ***e***; 1.15, ***f***.

According to the integration ratio of the imidazole protons (7.56-6.55 ppm) to the pyrene protons (8.46-7.92 ppm), the molar composition of **P3** was determined to be [1-vinyimidazole] : [PyMMA] = 97:3.

On the basis of the analysis of ^{1}H-NMR data, **P3** can be approximately treated as pure poly(1-vinylimidazole). By using 0.1 M of aqueous NaCl as solvent and employing the equation of $[\eta] = 0.122 \times \overline{M_v}^{0.51}$, $\overline{M_v}$ of **P3** was determined to be 15.5 kDa.

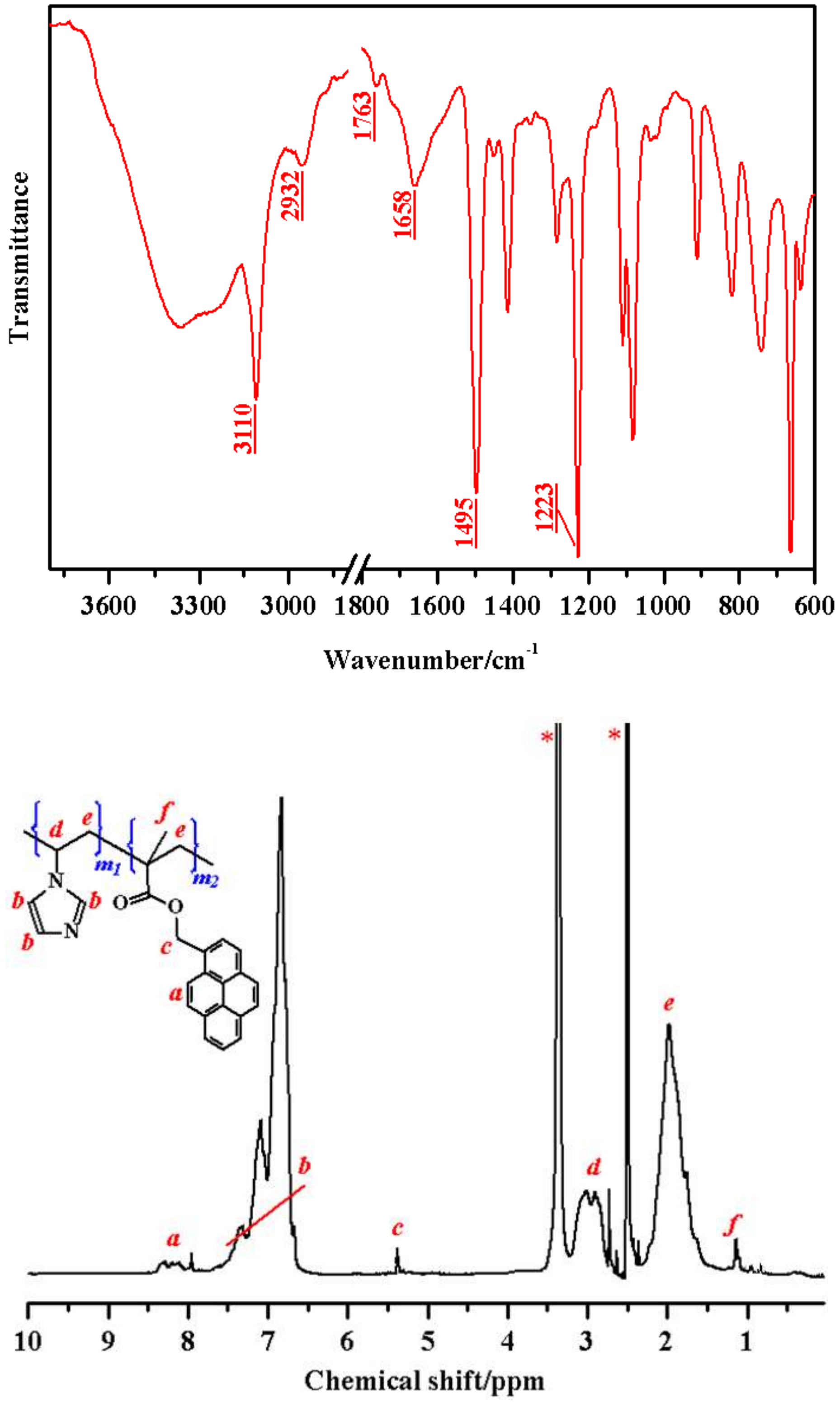

Fig. S3 FTIR (top) and ^{1}H-NMR (down) spectra of **P3**.

5. Synthesis of poly(1-vinyl-3-butylimidazolium chloride-*co*-1-vinylimidazole-*co*-PyMMA) (47/50/3) (P4)

2.2 ml (21.3 mmol) of 1-chlorobutane was added dropwise into a solution of **P3** (1.0 g, 10.6 mmol of vinylimidazole unit, which was determined based on the assumption that **P3** consists only of the vinylimidazole unit) in 20 ml ethanol at room temperature under an N_2 atmosphere. The reaction was subsequently performed for 24 h at 70 ^{o}C. After cooling to room temperature, the clear solution was poured into 80 ml of stirred ethyl acetate. The precipitate was separated by filtration through a 0.2 μm PTFE membrane, washed thoroughly with ethyl acetate, and vacuum-dried at 50 ^{o}C for 12 h to give the final product of **P4**. Fig. S4 shows the FTIR and ^{1}H-NMR spectra of **P4**.

FTIR (ν, cm^{-1}): =C-H, 3105; C-H in $-CH_3$, 2960; C-H in $-CH_2-$, 2926; C=N, 1648; C-N, 1495; C-O-C, 1225.

^{1}H-NMR (δ, ppm) (DMSO-d_6): 8.46-7.92, ***a***; 7.76-6.55, ***b***; 5.42, ***c***; 4.25-3.85, ***d***; 3.19-2.76, ***e***; 2.40-1.45, ***f-h***; 1.36-0.97, ***i*** and ***j***.

Elementary analysis (%): C 61.48±1.24; H 7.33±0.38; N 18.89±1.01; Cl 11.65±0.26.

From the elementary analysis data of **P4**, it is deduced that 48% of the imidazole units in **P3** have reacted with 1-chlorobutane. Therefore, the molar composition of **P4** was determined to be [1-vinyl-3-butylimidazolium chloride] : [1-vinyimidazole] : [PyMMA] = 47 : 50 : 3.

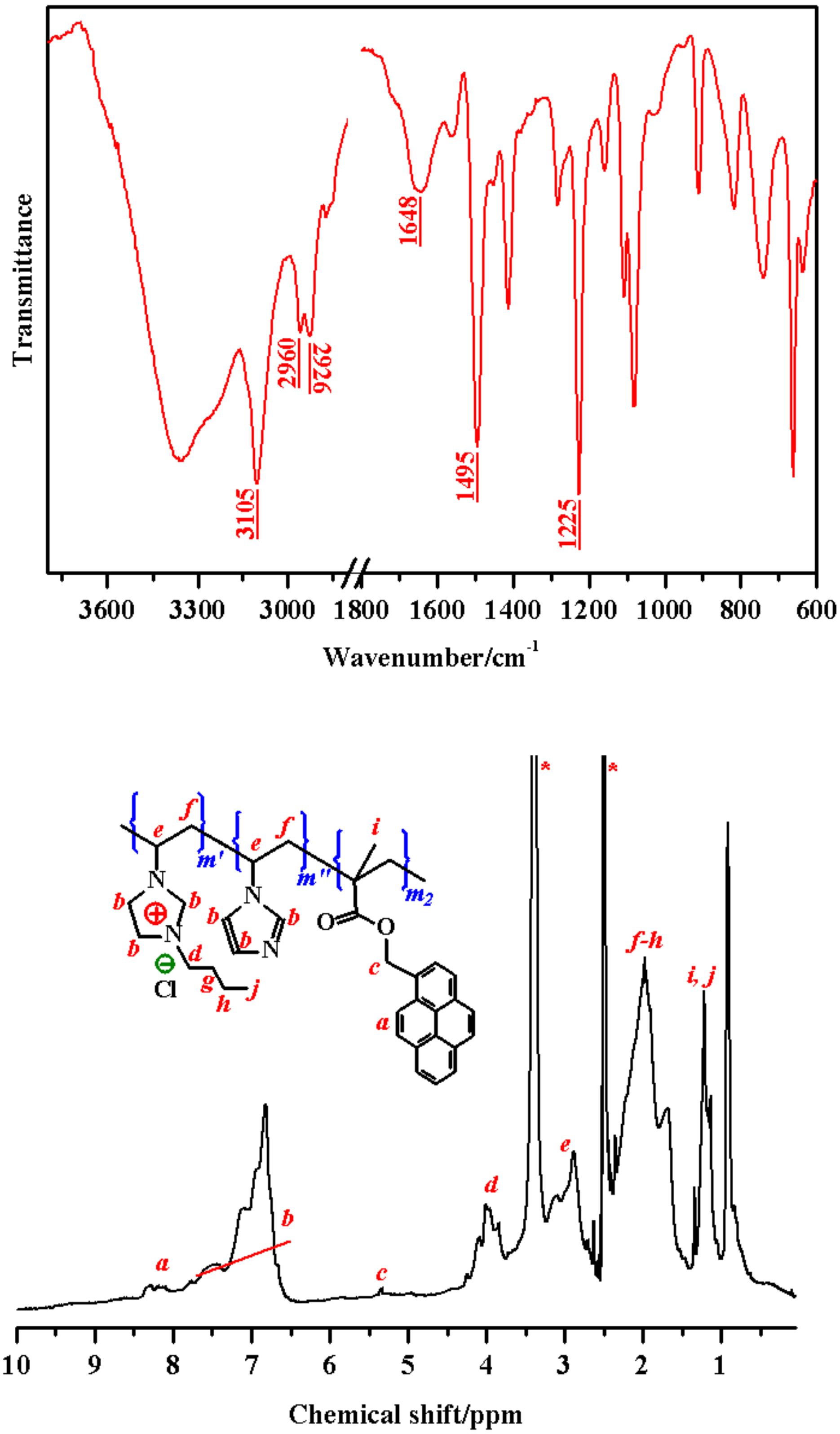

Fig. S4 FTIR (top) and ^{1}H-NMR (down) spectra of **P4**.

6. TEM images of prinstine SWNTs dispersed in water

0.01 mg.ml^{-1} of SWNTs were dispersed in water by sonication (Elmasonic E30H, 80 W, 37 kHz) for 30 min with water bath temperature maintained below 25 ^{o}C. The dispersion was immediately drop-casted on a holey carbon film coated-copper grid for preparation of TEM sample. After being fully dried under an infrared lamp, the sample was observed using a JEOL JEM-2100 microscope with an accelerating voltage of 200 kV.

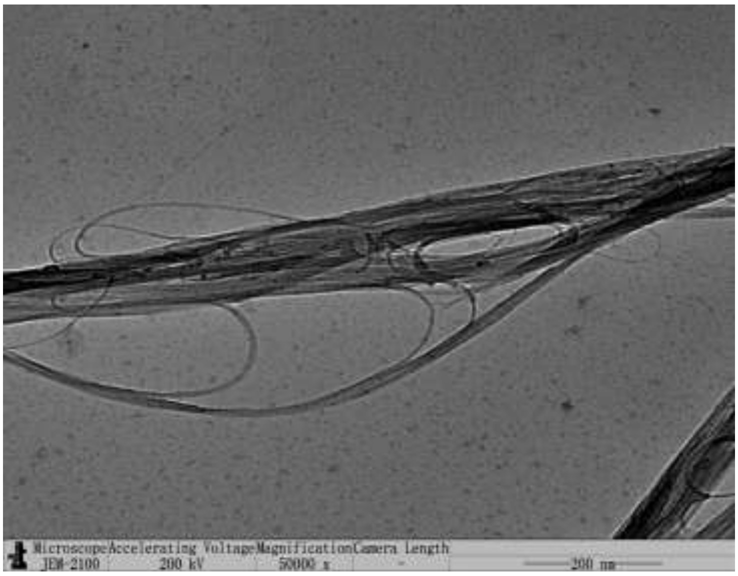

Fig. S5 TEM images of pristine SWNTs dispersed in water without any dispersants.

Table S1 Dispersibility of covalently or noncovalently functionalized SWNTs in water.

Covalently functionalized SWNTs			**Noncovalently functionalized SWNTs**			
Covalent functionalization method	Dispersibility of functionalized SWNTs /mg.ml^{-1}	Ref No.	Dispersant	Concentration of dispersant /mg.ml^{-1}	Dispersibility of SWNTs /mg.ml^{-1}	Ref. No.
Microwave-assisted functionalization of SWNTs in a mixture of nitric and sulfuric acids	10	1	α-Helical peptide	100 μM	0.7	7
Carboxylic acid functionalized SWNTs	0.7	2	Poly(*N*-cetyl-4-vinyl-pyridinium bromide-*co*-*N*-ethyl-4-vinylpyridinium bromide-*co*-4-vinylpyridine)	0.09*	<0.13*	8
Poly(*m*-aminobenzene sulfonic acid) grafted SWNTs	5.8	2	Starlike amphiphilic block copolymer with PPO-PEO segments (AP432)	1.0	<0.33	9
Poly(ethylene glycol) grafted SWNTs	5.9	2	Poly(vinyl pyrrolidone)	10	1.4	10
Amino acid grafted SWNTs	20	3	Poly(styrene sulfonate)	10	4.1	10
Poly(sodium 4-styrenesulfonate) grafted SWNTs	0.68	4	Sodium dodecylbenzenesulfonate	200	20	11
Tetrahydrofurfuryl-terminated polyethylene glycol grafted SWNTs	9.2	5	Sodium dodecyl sulphonate	20	0.025	12
Sugar azides functionalized SWNTs	0.6-1.3	6	*meso*-(tetrakis-4-sulfonatophenyl) porphine dihydrochloride	0.6l	0.04	13
			ss-DNA	1.0	0.2-0.4	14
			Fluorescein-poly(ethylene glycol)	5.0	<0.25	15

* a mixed solvent of water/DMF (5/2 v/v)

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