Supplementary Information

Highly Transparent Silver Nanowires-Polyimide Electrode for Snow-Cleaning Device

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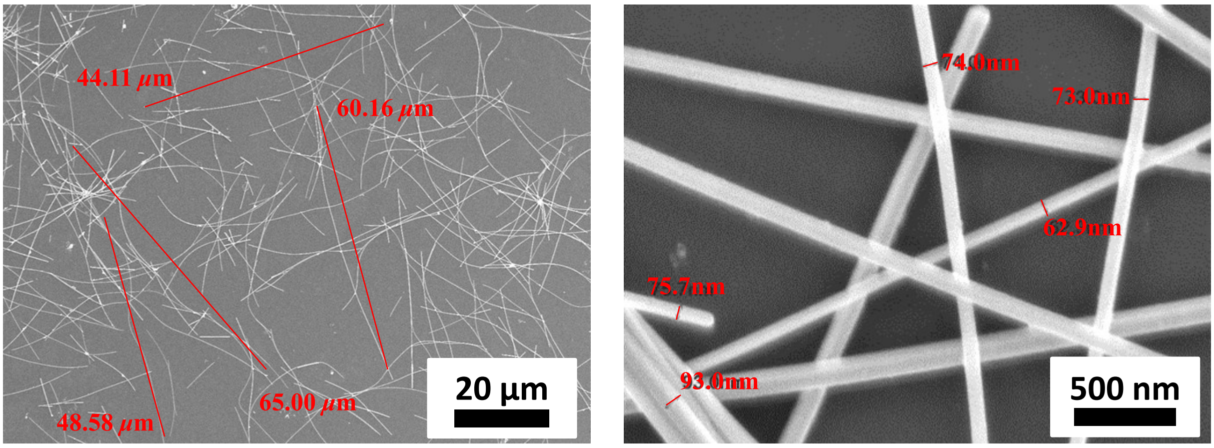

Figure S1 SEM photos of synthesized high aspect ratio AgNWs.

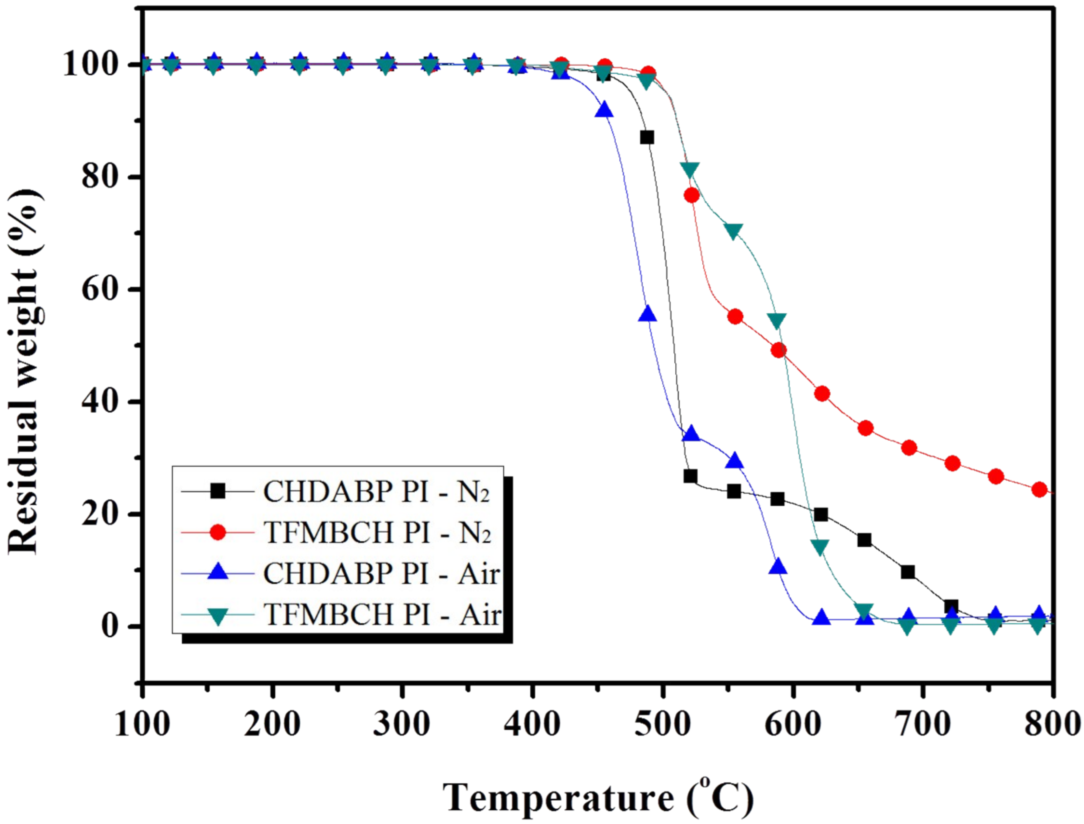

Figure S2 TGA curves of TFMBCH PI and CHDABP PI.

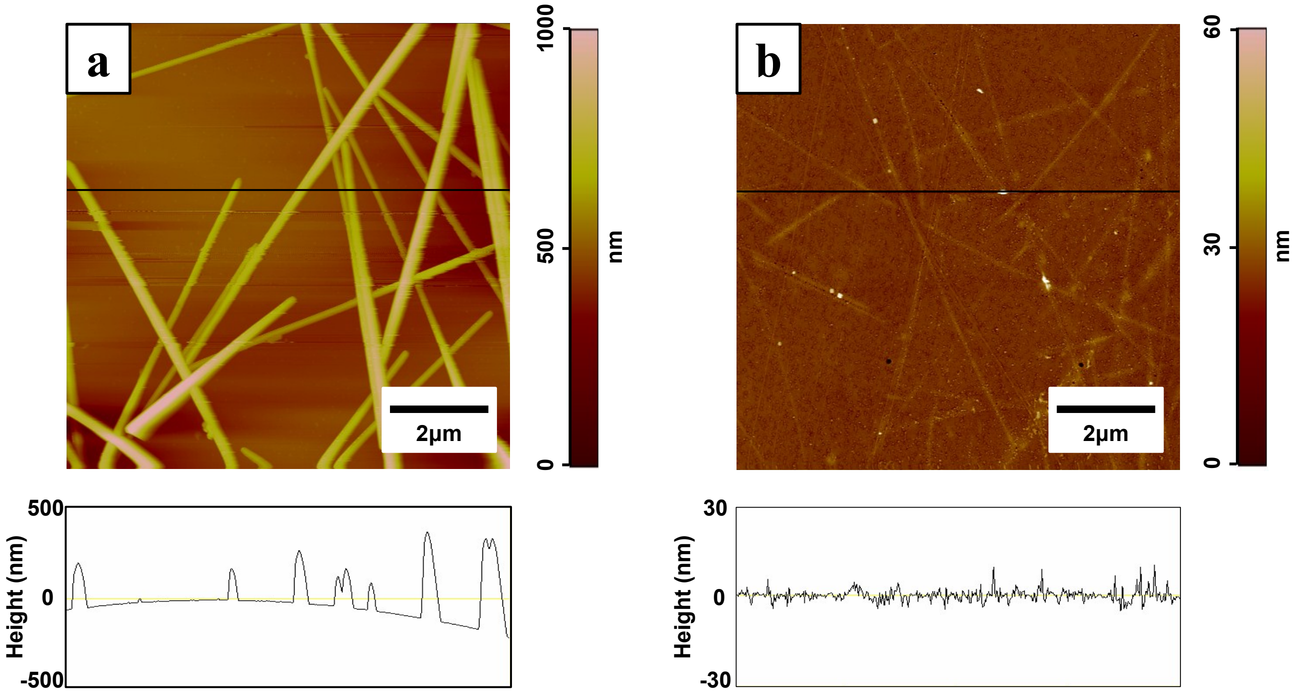

Figure S3 AFM topographic images of AgNW films (a) with and (b) without PI binder. Line profiles along the black lines are shown below the respective AFM images.

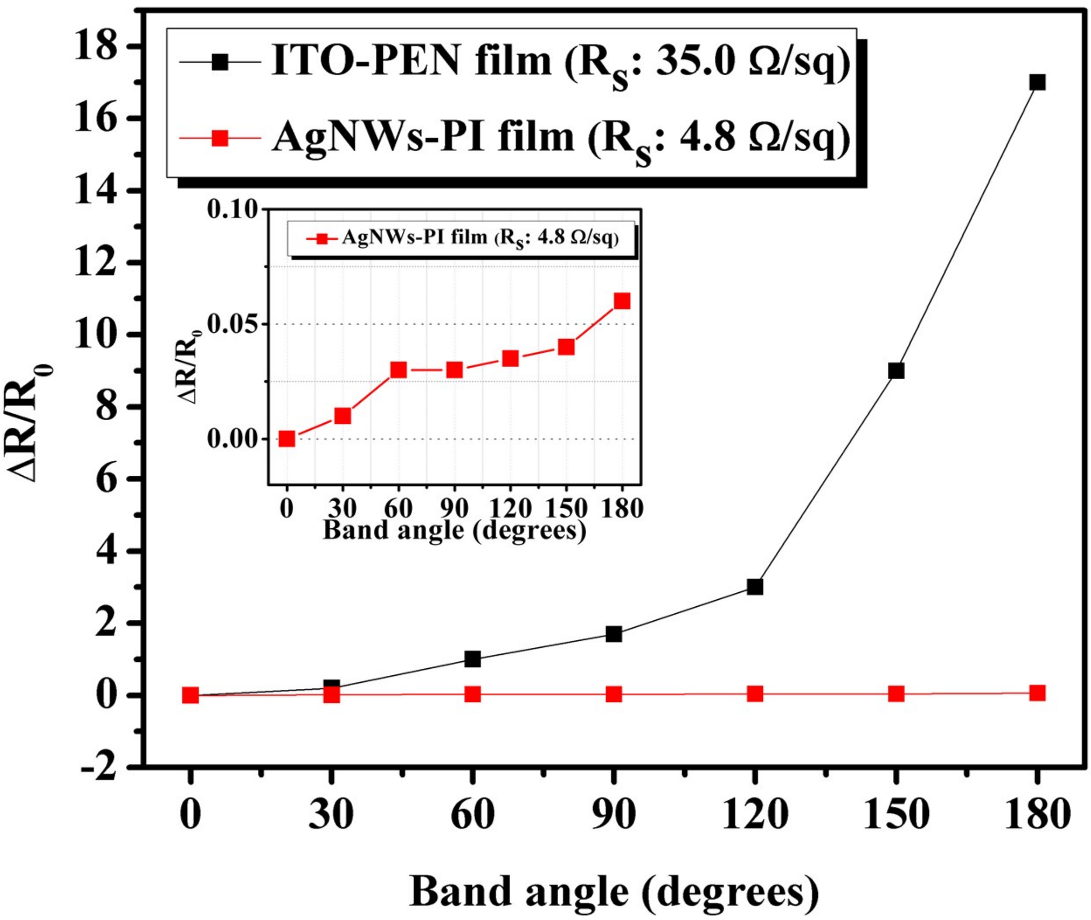

Figure S4 The sheet resistance dynamic change of AgNWs-PI hybrid film and ITO-PEN film at the bending experiment in different band angle.

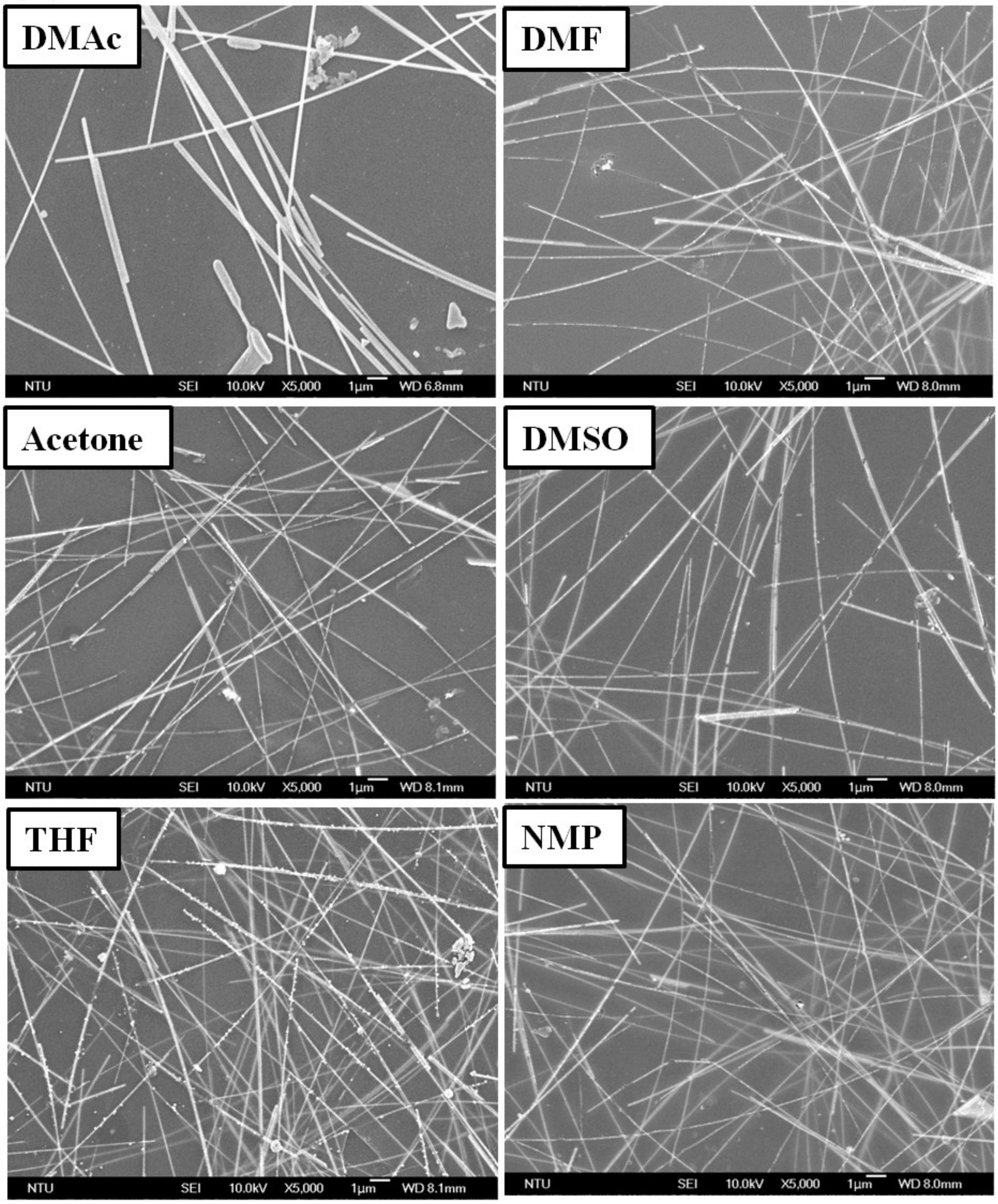

Figure S5 SEM morphology of AgNWs-PI hybrid films after dipping in various organic solvents for 20 hours, respectively.

Table S1 Solubility of TFMBCH PI, CHDABP PAA, and CHDABP PI

Polymer[a]	Solubility behavior in common organic solvent[b]							
	DMAc	NMP	DMSO	m-cresol	DCM	THF	DMF	acetone
TFMBCH PI	＋＋	＋＋	＋＋	＋－	＋－	＋＋	＋＋	＋＋
CHDABP PAA	＋＋	＋＋	＋＋	＋＋	－	＋＋	＋－	＋－
CHDABP PI	－	－	－	－	－	－	－	－

[a] Qualitative solubility was tested with more harsh condition: 10 mg of a sample in 1 mL of solvent.
[b]＋＋, soluble at room temperature; ＋, soluble on heating; ＋－, partially soluble or swelling; －, insoluble even on heating.

Table S2 Thermal properties of the polyimides

Polymer[a]	T_g[b] (°C)	CTE[c] (ppm/°C)	T_d^5(°C)[d]		T_d^{10}(°C)[d]		R_{w800}[e] (%)	LOI[f]
			N_2	Air	N_2	Air		
TFMBCH PI	405	78	480	470	505	510	28.5	28.9
CHDABP PI	390	8	480	440	490	450	5.5	19.7

[a] All polyimide films were heated at 300 °C for 1 h prior to all the thermal analyses.
[b] Glass transition temperature measured by TMA with a constant applied load of 10 mN at a heating rate of 10 °C/min by film/fiber mode.
[c] The coefficient of linear thermal expansion data were determined over a 50~200 °C range by TMA.
[d] Temperature at which 5 % and 10 % weight loss occurred, respectively, recorded by TGA at a heating rate of 20 °C/min and a gas flow rate of 20 cm^3/min.
[e] Residual weight percentages at 800 °C under nitrogen, also called as char yield.
[f] LOI = Limiting Oxygen Index = (17.5+0.4×char yield).

Table S3 Optical properties and color coordinate of the transparent polyimides

Polymer[a]	Color coordinate[b]			T (%)[c]		λ_o[d]
	L*	a*	b*	400nm	550nm	(nm)
TFMBCH PI	96.20	-0.11	0.69	90	91	284
CHDABP PI	94.35	-0.24	1.56	85	87	350

[a] The thickness of all the colorless polyimide films are about 30 μm.
[b] The CIE 1976 (L*, a*, b*) color space.
[c] Transmittance at 400 nm and 550 nm of wavelength measured by UV-vis.
[d] Cutoff wavelength of polyimide.

Table S4 Examples and comparisons for AgNWs-polymer hybrid systems

Substrate type	Aspect ratio of AgNWs	R_s (Ω/sq)	T_{550nm}[a] (%)	FoM	Notes	Ref.
PET	640	4	63	180	Hybrid with CNT	S1
	250	26	90	135	Hybrid with CNT	S2
	350	13	88	220	Hybrid with graphene oxide	S3
	260	10	84	200	Hybrid with PEDOT:PSS	S4
	330	33	84	65	Hybrid with PEDOT:PSS	S5
	500	20	80	80	Solar cell	S6
	500	91	97	195	Heater	S7
PDMS	165	10	85	220	Filter vacuum transferring	S8
	450	15	82	120	Stamp transferring	S9
	500	14	80	115	Filter vacuum transferring	S10
	350	7	63	100	Filter vacuum & pressing	S11
	500	70	90	50	Filter vacuum transferring	S12
Polyacrylate	250	17.5	85.1	130	Transferring & press	S13
	100	30	86	80	Transferring	S14
	100	35	85	64	Transferring	S15
PU	165	8	75	155	Transferring	S16
	10	80	86	20	Dip coating	S17
PC	215	29	92	150	Electrostatic Spraying	S18
	230	88	80	18	Drop casting	S19
PVA	110	10	80	160	Hybrid PEDOT:PSS Filter vacuum transferring	S20
	220	50	85	45	Hybrid PEDOT:PSS Spin coating	S21

[a] Transmittance at 400 nm and 550 nm of wavelength measured by UV-vis.

Table S5 A partial list of performance of AgNWs-PI films reported in literatures

Publish year	Ref.	PI	λ_0[a] (nm)	T (%)[b]		Rs (Ω/sq)	FoM		Application
				400 nm	550 nm		400 nm	550 nm	
2012	S22	Commercial[c]	350	30	85	21.7	10	105	Solar cell
2013	S23	Commercial[c]	-	80	89	33.0	48	105	Wearable electronics
2014	S24	Commercial[d]	360	30	90	15	15	230	Heater
2015	S25	-[e]	390	20	40	4	40	80	Solar cell
	S26	TFMBCH PI	300	40	58	5.6	58	105	Heater
	S27	6FDACH PI	276	68	74	7	125	160	Heater/ECD
This work		TFMBCH/ CHDABP PI	290	57	70	3.5	165	260	Heater

[a] Cutoff wavelength of polyimide.
[b] Transmittance at 400 nm and 550 nm of wavelength measured by UV-vis.
[c] Not mentioned.
[d] Product model of commercial PI: VTEC-080051.
[e] Not mentioned.

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