Electronic Supplementary Material (ESI) for RSC Advances.

Electronic Supporting Information (ESI)

PVAc/PEDOT:PSS/Graphene-Iron Oxide Nanocomposite (GINC): An Efficient Thermoelectric Material

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Table S1: Thermoelectric properties of GINC based composition

Sr. No	Composition	Electrical conductivity (σ) S/m (20°C)	Seebeck coefficient (*S*), µV/k	Power Factor(PF) µW/mK^2	Density g/cc	Thermal diffusivity (cm^2/sec)	Specific heat (J/Kg.K)	Thermal conductivity (κ) W/mK	Figure of merit (ZT) at 300K	Band Gap (eV)
CP-1	15% PVAc+ 5% PEDOT:PSS solution +80% GINC	3717.47	22.16	1.83	2.158	0.0090 0.0087	2360.4 2348.3	4.57 4.40	1.20×10^{-4} 1.24×10^{-4}	3.11
CP-2	10% PVAc+ 10% PEDOT:PSS solution +80% GINC	5053.05	14.87	1.12	2.026	0.0056 0.0058	3244.2 3256.4	3.68 3.82	0.91×10^{-4} 0.88×10^{-4}	3.13
CP-3	5% PVAc+ 15% PEDOT:PSS solution +80% GINC	5099.43	19.81	2.02	2.167	0.0035 0.0035	4321.9 4260.1	3.24 3.19	1.87×10^{-4} 1.89×10^{-4}	3.32
CP-4	20% PEDOT:PSS solution +80% GINC	67385.44	22.52	34.17	2.345	0.0040 0.0038	3564.2 3552.2	3.34 3.16	0.003 0.003	3.25

Table S2: Thermoelectric properties of GINC based composition

Sr. No	Composition	Electrical conductivity (σ) S/m (20ºC)	Seebeck coefficient (*S*), µV/k	Power Factor(PF) µW/mK^2	Density g/cc	Thermal diffusivity (cm^2/sec)	Specific heat (J/Kg.K)	Thermal conductivity (κ) W/mK	Figure of merit (ZT) at 300K	Band Gap (eV)
CP-1.	5% PEDOT:PSS solution +95% GINC	80321.3	25.42	51.93	2.303	0.0015 0.0014	2607.2 2620.5	0.90 0.84	0.017 0.018	3.26
CP-2.	10% PEDOT:PSS solution +90% GINC	54463.23	24.81	33.53	2.32	0.0024 0.0026	3021.2 3024.3	1.68 1.82	0.006 0.005	3.27
CP-3	20% PEDOT:PSS solution +80% GINC	67385.44	22.52	34.17	2.345	0.0040 0.0038	3564.2 3552.2	3.34 3.16	0.003 0.003	3.25
CP-4	30% PEDOT:PSS solution +70% GINC	73964.49	26.20	50.77	2.516	0.0030 0.0032	3654.4 3647.2	2.75 2.93	0.005 0.005	3.07
CP-5	40% PEDOT:PSS solution +60% GINC	88731.14	22.20	43.73	2.185	0.0032 0.0028	3745.5 3726.8	2.61 2.28	0.005 0.006	3.31

Table S3: Thermoelectric properties of graphene based composition

Sr. No	Composition	Electrical conductivity (σ) S/m (20°C)	Seebeck coefficient (*S*), µV/k	Power Factor(PF) µW/mK^2	Density g/cc	Thermal diffusivity (cm^2/sec)	Specific heat (J/Kg.K)	Thermal conductivity (κ), W/mK	Figure of merit (ZT) at 300 K	Band Gap (eV)
CP-1	5% PEDOT:PSS solution +95% Graphene	172057	8.85	13.48	1.85	0.0292 0.0290	2512.2 2513.2	13.57 13.52	0.0003	3.12
CP-2	10% PEDOT:PSS solution +90% Graphene	81726	8.2	5.4	1.48	0.0270 0.0268	2365.3 2363.2	9.45 9.37	0.0002	3.04
CP-3	20% PEDOT:PSS solution +80% Graphene	242541	7.5	13.64	1.75	0.0243 0.0245	2209.4 2211.7	9.39 9.48	0.0004	3.20
CP-4	30% PEDOT:PSS solution +70% Graphene	185125	9.75	17.6	1.89	0.0213 0.0214	2021.9 2013.1	8.15 8.13	0.0006	3.06
CP-5	40% PEDOT:PSS solution +60% Graphene	133333	11.17	16.65	1.70	0.0198 0.0192	1976.3 1982.2	6.65 6.46	0.0008	3.02

Table S4: Thermoelectric properties of Cellulose/GINC-PEDOT:PSS COMPOSITE paper

Sr. No	Composition	Electrical conductivity (σ) S/m (20°C)	Seebeck coefficient (*S*), µV/k	Power Factor(PF) µW/mK^2	Density (g/cc)
1.	Cellulose paper+PEDOT:PSS- GINCcomposite (10 wt. %)	2424.2	10.1	0.2	0.058
2.	Cellulose paper+ PEDOT:PSS- GINCcomposite (15 wt. %)	5430	15.2	1.2	1.883

3.	Cellulose paper+ PEDOT:PSS- GINCcomposite (20 wt. %)	8730	14.3	2.9	1.058
4.	Cellulose paper+ PEDOT:PSS- GINCcomposite (30 wt. %)	14060	20.0	5.6	1.058
5.	Cellulose paper+ PEDOT:PSS- GINCcomposite (40 wt. %)	18876	--	--	0.928

Table S5: Summary of thermoelectric properties of the best composite of inorganic and organic materials.

Thermoelectric materials	**σ, S/m**	***S*, µV/k**	**κ,** W/mK	**Calculated PF (*$S^2\sigma$*),** µW $m^{-1}K^2$
PANi + SWCNT composites with different SWCNT [Ref. 1]	10-125 (RT)	11-40 (RT)	0.5-1 (RT)	0.5-5 (300K)
PANi+ unoxidized SWCNT [Ref.2]	5.30×10^4	33		0.6
PANi+ HCL+ MWCNT(40%) [Ref.3]	1.71×10^3	10	--	0.17
PANI+CNT (15.8%) [Ref: 4]	6.1×10^3	29	0.4-0.5	PF=5
CNT+graphite+polylactic acid [Ref. 5]	4.123×10^3	17	5.5	ZT=7.2×10^{-5} at RT
P3HT+MWCNT (30%) [Ref.6]	11	11.3 at 493K	--	--
P3HT+MWCNT (5%) [Ref. 7]	1.31×10^{-1}	131	--	--
P3HT+SWCNT (81%)	1.8×10^4	32	0.13	18
P3HT+$FeCl_3$+ SWCNT (42-81%)	1.1×10^5	29	--	95
P3HT+$FeCl_3$+ MWCNT (10-40%)	8×10^3	29	--	6
P3HT+$FeCl_3$+ MWCNT (50%) [Ref. 8]	1×10^3	12	0.16	0.2
PEDOT:PSS+CNT(35%) [Ref. 9]	4×10^4	--	0.2-0.4	ZT=0.02
PEDOT:PSS+ SWCNT(20-95%) [Ref. 10]	6×10^4-3.6×10^5	15-28	0.56	42-95
Nafion +MWCNT (10-50%) [Ref.11]	0-8	20-26	--	0.5
Nafion +FWCNT (10 -50%) [Ref. 5]	0-13	17-24	--	0-1
Nafion +SWCNT (10-50%) [Ref. 5]	0-1	25-30	--	0.1-0.2
Graphene [Ref. 12]	10^6	5000	--	ZT= 0.006 at 300K

PANi/Graphene composite [Ref. 13]				
PANi	10^3	14	--	0.2
Graphene	2×10^4	15	--	8
Pallet :				
PANi :Graphene:: 4:1 to 1:1	1.4×10^3- 5×10^3	20-30	--	0.7-5.6
Film				
PANi :Graphene:: 4:1 to 1:1	20-700	27-41	--	0.04-1.2
PANi + HCL +Graphene (50%) [Ref. 14]	123	34	3.3	14
PANi+GNP (In situ polymerization with protonation ratio- 0.2)				
Neat PANi				ZT (300K)=
Neat GNP	150	7	0.6	3.68×10^{-6}
PANi/GNP (50mM, as made)	2×10^4	5	74	3.04×10^{-6}
PANi/GNP (50mM, reprotonated)	5900	33	13	1.51×10^{-4}
[Ref.15]	1.74×10^4	19	15	1.26×10^{-4}
PANI + 30% Graphene [Ref. 16] (Insitu polymerization)	5×10^3 at 323K	12	**--**	ZT= 1.95 $\times 10^{-3}$ at 453 K
PANI at 420K	500	13	--	0.1
PANI + 5-30% Graphene [Ref. 16].	700-4.0×10^3	28-32	--	0.4-2.6
PANI+$HClO_4$+Graphite (50 wt.%) [Ref. 17].	1.2×10^4	19	1.2	1.2
PEDOT:PSS+GNP(2-3%), [Ref. 18]				
PEDOT:PSS + GN (1-4%)	74-3170	44.75-165.8	0.14-0.30	
PEDOT:PSS/Graphene (1-5%) [Ref. 19]	52800-63700	21.750-26.778	--	PF= 26.444-45.677

S-6: References

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