

Supplementary files:

Non-isothermal crystallization kinetics of polypropylene/short-glass fibre /multiwalled carbon nanotube composites

Nanoth Rasana ^a, Karingamanna Jayanarayanan ^{*b}, Alessandro Pegoretti^c

^a*Department of Chemical Engineering and Materials Science, Amrita School Of Engineering, Coimbatore, Amrita Vishwa Vidyapeetham, India*

^b*Centre of Excellence in Advanced Materials and Green Technologies (CoE-AMGT), Amrita School of Engineering, Coimbatore, Amrita Vishwa Vidyapeetham, India.*

^c*Department of Industrial Engineering, University of Trento, Via Sommarive 9, 38123 Trento, Italy.*

Corresponding author : kj_narayanan@cb.amrita.edu, kjnarayanan@gmail.com

Table S1 Stress -strain values of neat PP, PPC, PPG and PPGC composites

Sample	Tensile Strength (MPa)	Young's Modulus (MPa)	Strain at break (%)
PP	29.2±0.5	1100±31	20±1.5
PPC1	31.7±0.7	1186±52	16.2±0.8
PPC3	33.9±0.7	1523±59	9±0.4
PPC5	36±0.6	1587±47	7.5±0.3
PPG	41.9±1.2	2542±78	2.8±0.2
PPGC1	46.3±0.6	2210±55	3.4±0.1
PPGC2	47.7±0.5	2456±92	3.7±0.2
PPGC3	51.4±1.3	2500±68	4.9±0.4
PPGC5	48.4±0.8	2200±71	5.5±0.3

Table S2 Crystallization characteristics of neat PP, PPG and PPGC composites at different cooling rates.

Specimens	R (°C/min)	T _o (°C)	T _c (°C)	T _e (°C)	T _m (°C)	t _½ (min)	Δw (°C)
Neat PP	5	119.8	113.13	109.1	167.15	1.1	5
	10	117	111.43	106.4	165.86	0.53	5.2
	15	116.5	109.61	103.5	165.19	0.44	5.8
	20	114.8	108.62	101	165.61	0.35	6.5
PPG	5	129.9	125.8	121.4	164.98	0.86	3.6
	10	126.8	122.22	117.8	163.01	0.45	4.4
	15	125.2	119.49	113.8	166.81	0.38	5.1
	20	122.4	116.58	109.8	163.48	0.31	5.9
PPGC1	5	133	127.02	123.2	165.3	0.98	3.5
	10	127.2	122.95	117.8	167.33	0.47	4.1
	15	127	122.47	116.5	165.43	0.35	5.5
	20	125.5	119.82	112.6	165.43	0.32	6.8
PPGC2	5	134.8	129.55	126.25	164.84	0.85	4
	10	130.2	125.03	119.8	165.76	0.52	5.4
	15	127.5	121.72	115	167.41	0.41	6.4
	20	127.2	121.12	113.2	165.27	0.34	7.25
PPGC3	5	133.8	128.6	125	166.04	0.882	4.2
	10	131.4	126.27	121.5	164.53	0.498	4.6
	15	129	122.61	115.2	165.33	0.463	6.3
	20	126.6	119.7	109.8	165.34	0.422	8.3
PPGC5	5	134.3	128.91	123.3	165.65	1.1016	4.4
	10	130	125.30	119	167.36	0.55	5.8
	15	128.5	123.88	116.5	163.67	0.4016	5.9
	20	127	121.27	113	165.90	0.3533	7.4

Table S3 Avrami parameters for non-isothermal crystallization of neat PP, PPG and PPGC composites

Samples	Avrami parameters	Cooling rate ($^{\circ}\text{C}/\text{min}$)			
		5	10	15	20
PP	log Z	-0.306	-0.038	0.443	0.639
	log Z_c	-0.061	-0.004	0.029	0.032
	Z_c	0.94	0.99	1.03	1.03
	n	1.75	1.63	1.55	1.54
	Average n	1.62			
PPG	log Z	-0.058	0.464	0.569	0.727
	log Z_c	-0.012	0.046	0.038	0.036
	Z_c	0.98	1.05	1.04	1.04
	n	2.56	2.32	1.89	1.65
	Average n	2.11			
PPGC1	log Z	-0.038	0.409	0.676	0.715
	log Z_c	-0.008	0.041	0.045	0.036
	Z_c	0.99	1.04	1.05	1.04
	n	2.82	2.52	2.12	1.81
	Average n	2.32			
PPGC2	log Z	-0.01	0.429	0.697	0.825
	log Z_c	-0.002	0.043	0.047	0.041
	Z_c	1.00	1.04	1.05	1.04
	n	3.8	2.89	2.72	2.1
	Average n	2.87			
PPGC3	log Z	-0.072	0.501	0.625	0.650
	log Z_c	-0.014	0.050	0.042	0.032
	Z_c	0.99	1.05	1.04	1.03
	n	3.73	3.31	2.8	2.5

	Average n	3.1			
PPGC5	log Z	-0.166	0.354	0.622	0.685
	log Z _c	-0.033	0.035	0.041	0.034
	Z _c	0.967	1.04	1.04	1.03
	n	3.2	2.68	2.47	2.32
	Average n	2.73			

Table S4 Parameters of Mo's model for non-isothermal crystallization of PP, PPG and PPGC composites

Samples	Mo's parameters	Relative crystallinity (%)				
		10	30	50	70	90
PP	α	0.84	0.95	1.01	1.08	1.19
	Log F(T)	0.46	0.70	0.81	0.89	0.99
	F(T)	1.58	2.01	2.25	2.44	2.69
	R ²	0.986	0.980	0.976	0.973	0.971
PPG	α	1.01	1.19	1.28	1.35	1.44
	log F(T)	0.35	0.54	0.65	0.74	0.87
	F(T)	1.42	1.72	1.92	2.09	2.39
	R ²	0.978	0.981	0.979	0.977	0.973
PPGC1	α	0.95	1.12	1.22	1.32	1.42
	log F(T)	0.38	0.56	0.66	0.75	0.87
	F(T)	1.46	1.75	1.93	2.12	2.38
	R ²	0.991	0.987	0.984	0.982	0.979
PPGC2	α	0.89	1.02	1.33	1.48	1.71
	log F(T)	0.46	0.61	0.67	0.76	0.89
	F(T)	1.58	1.84	1.95	2.14	2.44
	R ²	0.964	0.983	0.991	0.993	0.996
PPGC3	α	0.98	1.18	1.29	1.41	1.50
	Log F(T)	0.37	0.56	0.66	0.77	0.92
	F(T)	1.44	1.75	1.93	2.16	2.51
	R ²	0.98	0.985	0.979	0.978	0.982
PPGC5	α	0.93	1.04	1.12	1.20	1.25
	Log F(T)	0.41	0.62	0.72	0.82	0.96
	F(T)	1.51	1.86	2.05	2.27	2.61
	R ²	0.963	0.976	0.979	0.981	0.984

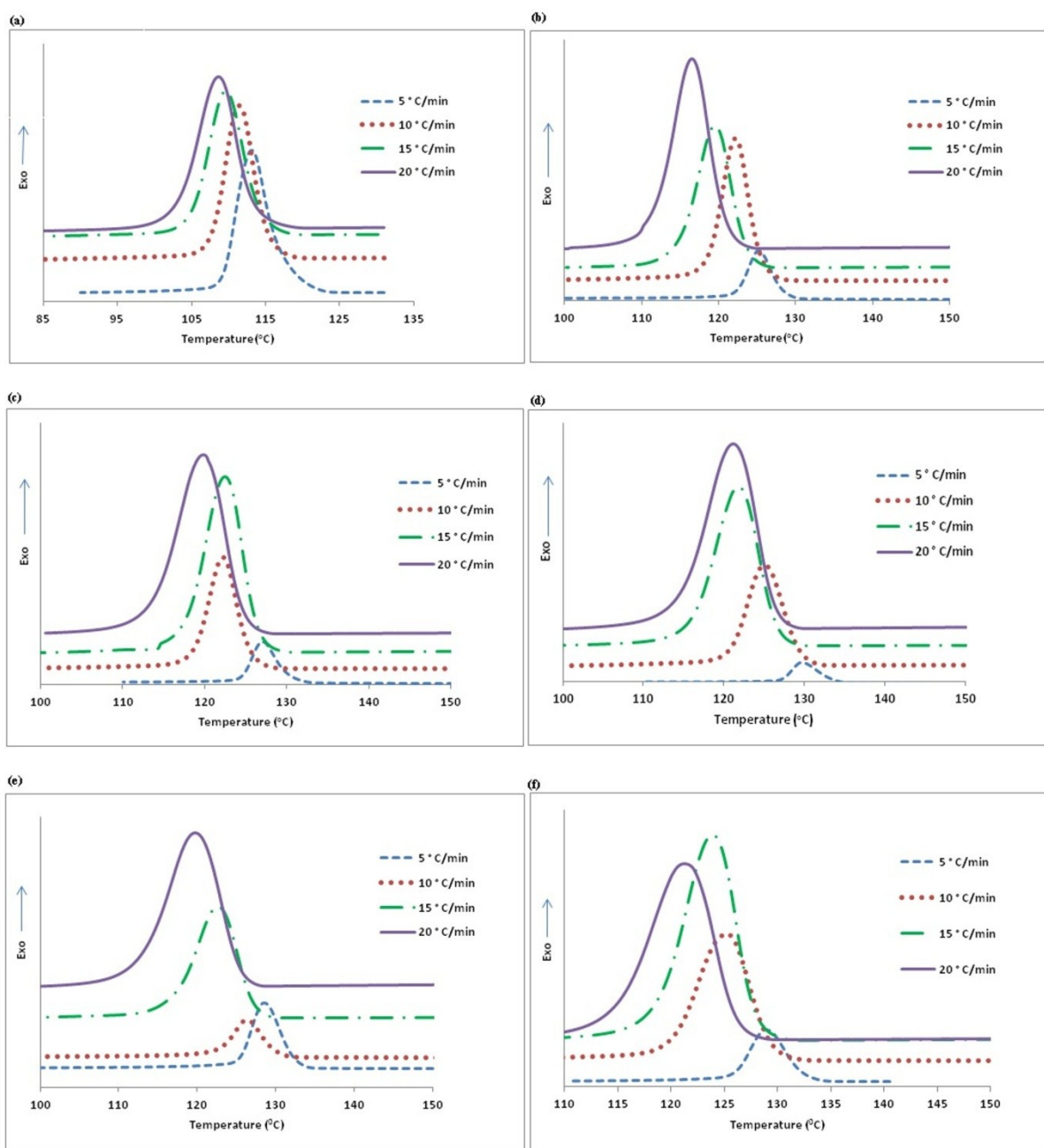


Fig. S1 Non isothermal crystallization exotherms of a) PP, b) PPG, c) PPGC1, d) PPGC2, e) PPGC3, f) PPGC5 at different cooling rates.

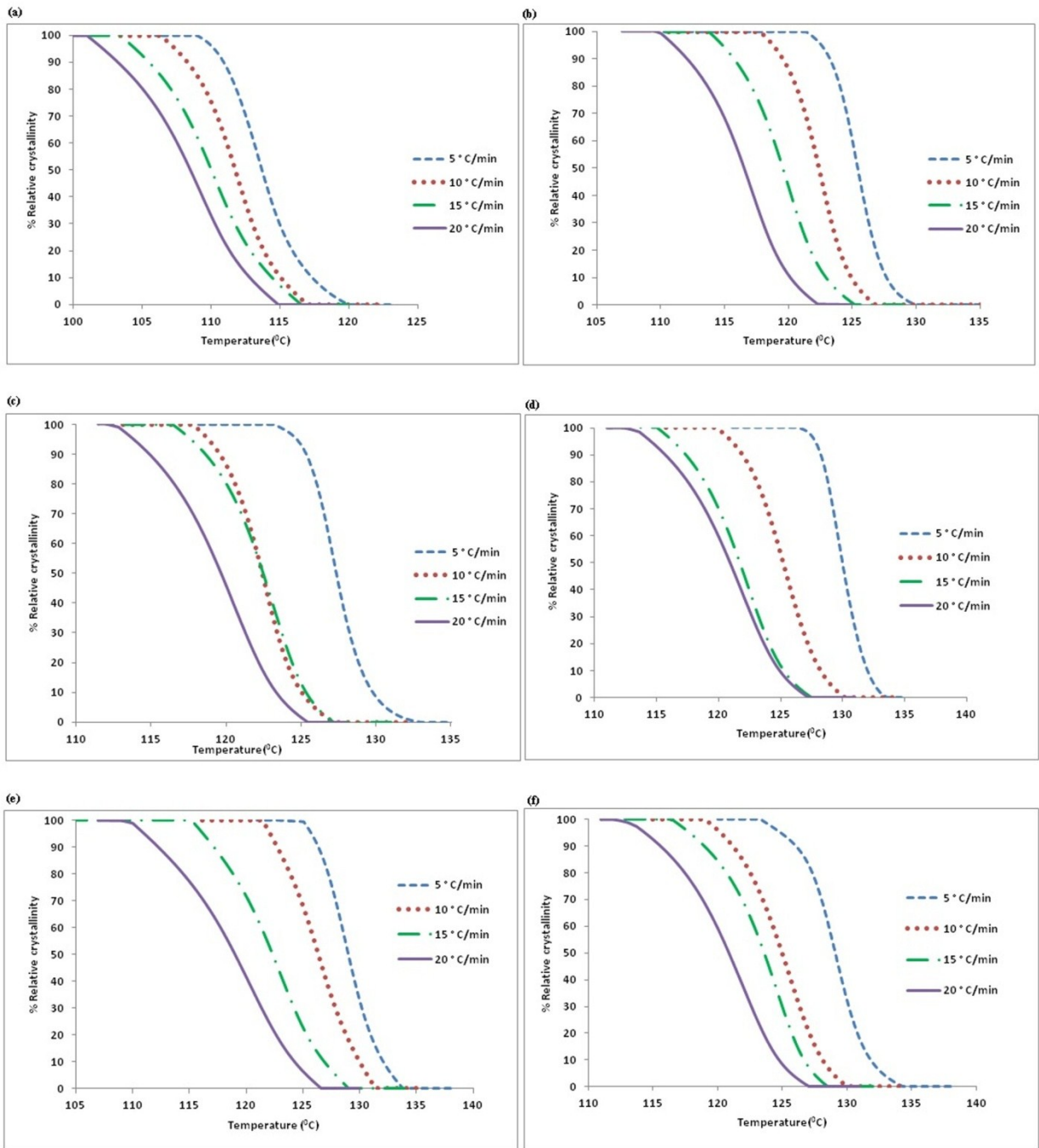


Fig. S2 The percent relative crystallinity ($X(T)$) of PP and composites as a function of temperature at varying cooling scans a) PP, b) PPG, c) PPGC1, d) PPGC2, e) PPGC3, f) PPGC5

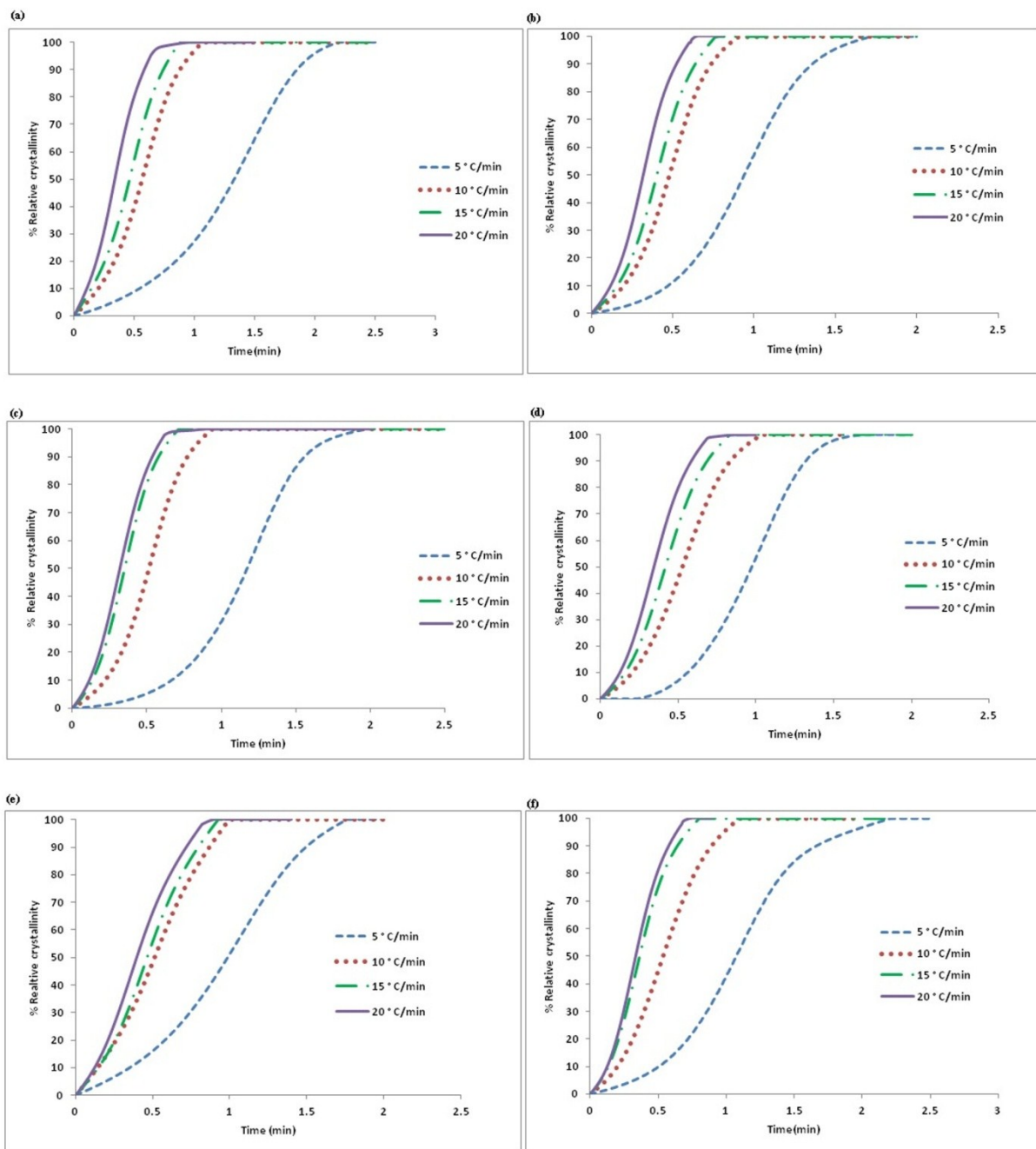


Fig. S3 The percent relative crystallinity $X(t)$ as a function of time at varying cooling scans
 a) PP, b) PPG, c) PPGC1, d) PPGC2, e) PPGC3, f) PPGC5

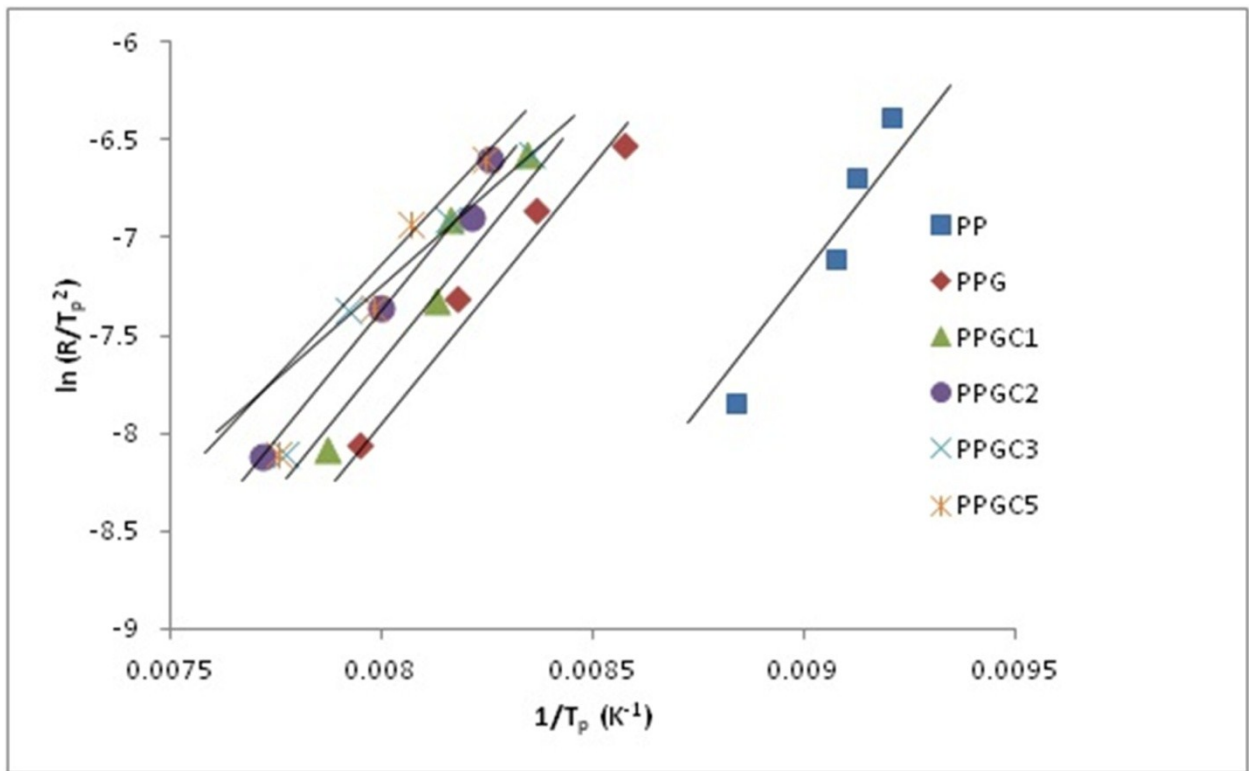


Fig. S4 Kissinger's plot of $\ln(R/T_p^2)$ vs. $(1/T_p)$ for PP, PPG and PPGC composites.

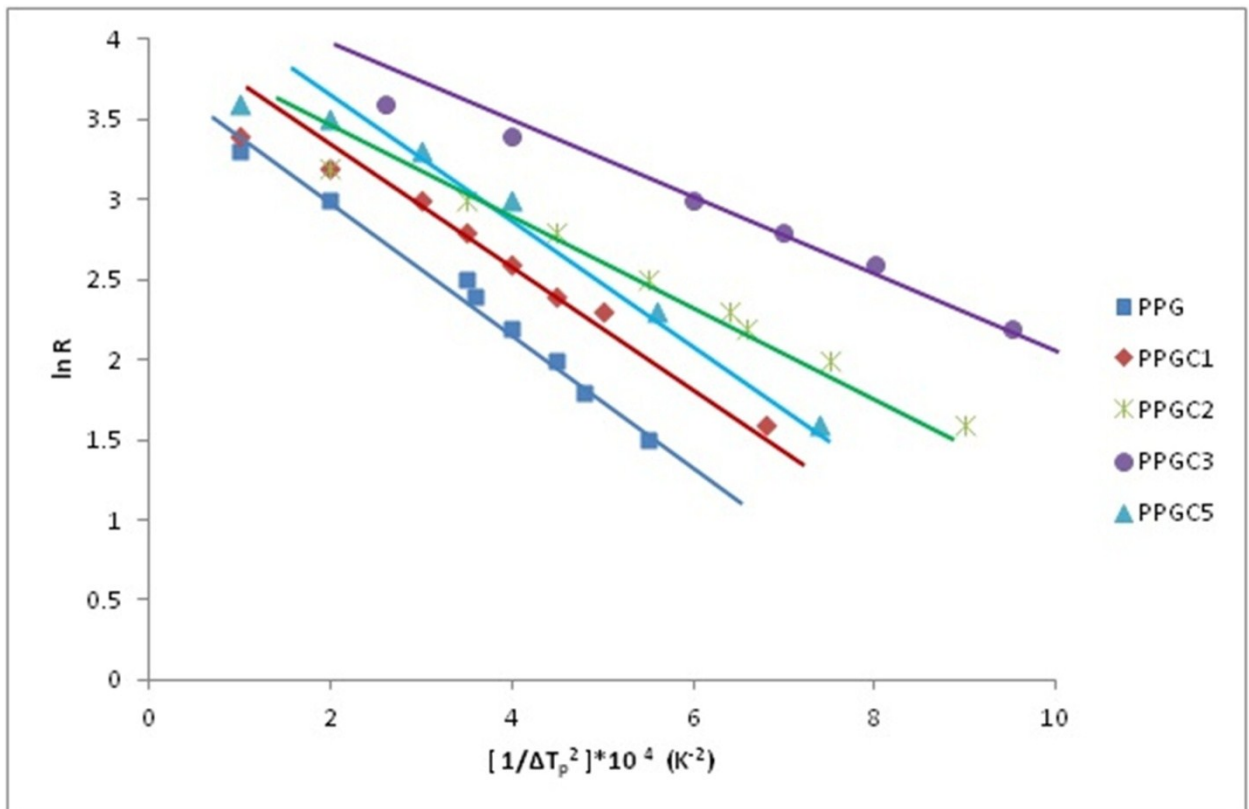


Fig. S5 Plots of ln R vs. $1/\Delta T_p^2$ for PP, PPG and PPGC composites