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A novel approach to obtain conductive tracks on PP/MWCNTs nanocomposites by laser printing

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Electronic Supplementary Information (ESI)

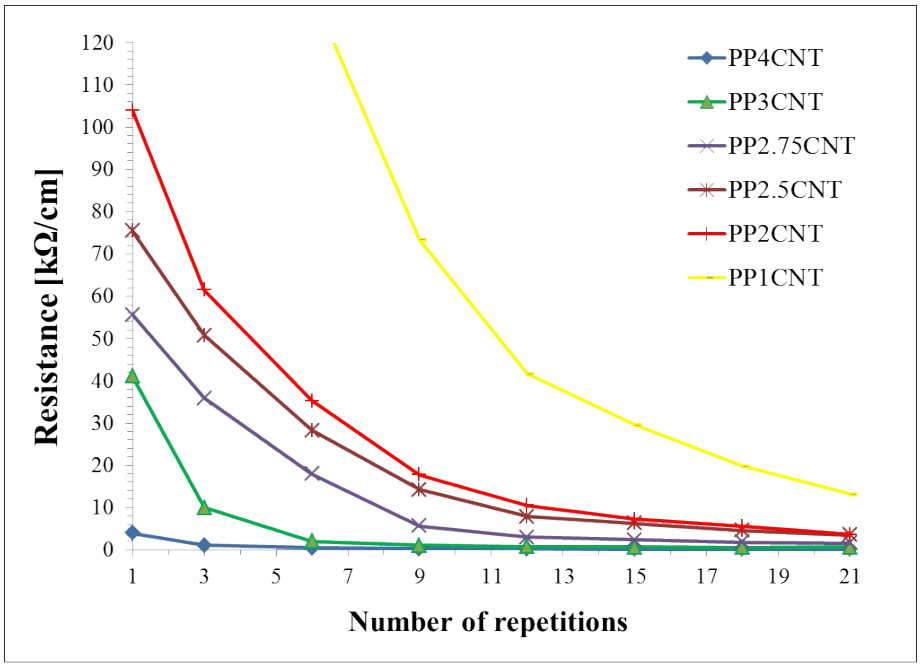


Figure S1. Electrical resistance behavior as function of the number of repetitions for PP-based nanocomposites with different weight percentages of MW-CNTs.

Table S1. Electrical resistance values, inter-track and on-track, for PP-based nanocomposites containing different wt.% of MW-CNTs to determine the percolation threshold.

Sample	Inter-track Resistance (kΩ/cm)	On-track Resistance (kΩ/cm)
PP4CNTs	10	10^{-2}
PP3CNTs	10	10^{-1}
PP2.75CNTs	10^{2}	10^{-1}
PP2.5CNTs	10^{3}	1
PP2CNTs	OL	1
PP1CNTs	OL	10

OL= OverLoad (> 120MOhm)

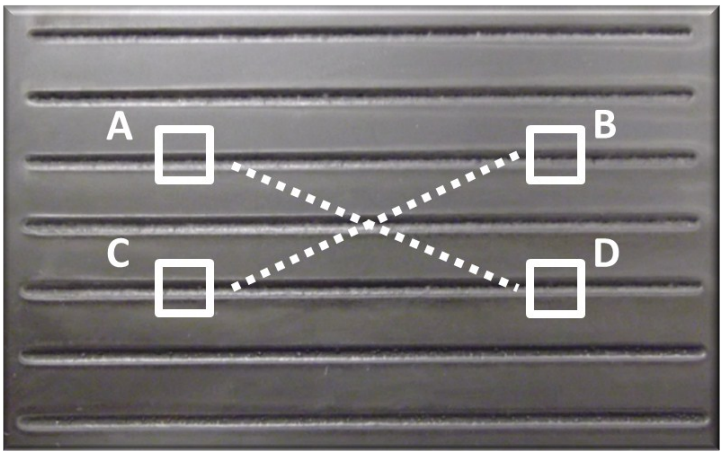
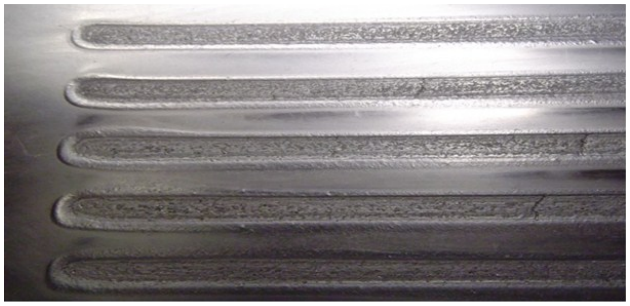


Figure S2. Photograph of PP-CNTs nanocomposites with conductive tracks obtained by laser printing: the pathways AB and CD give conductivity on-track, the pathways AD and BC represent inter-track conductivity.

Table S2. Laser printing parameters for obtaining PP2CNTs conductive tracks.

Laser treatment	Defocusing (mm)	Writing speed (mm/s)	Number of Repetitions	Frequency (kHz)	Power (%)	Resistance (kΩ/cm)
1	0-150	150	10-40	10	20	16.8-0.34
2	150	150	20-40	10	20-50	2.9-1.3
3	50	100-200	20-40	10	15	14.0-1.9
4	50	150-250	20-30	15	15	3.2-0.95
5	100	150-200	30	0.1-20	20	4.1-1.35
6	0-150	150	25	10	10-40	7.2-1.42

(a)



(b)

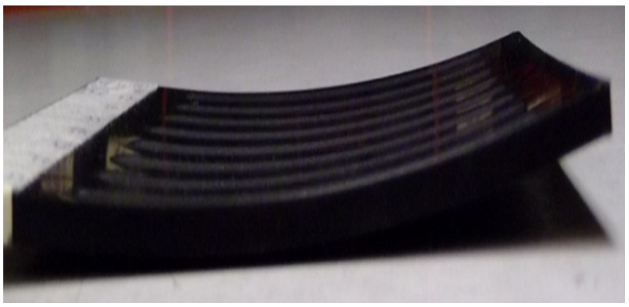


Figure S3. Images of deformations obtained on PP2CNTs conductive tracks obtained by laser printing treatments: formation of melted polymer phase in the region interested by the laser beam (a) and deformation of the planar structure at the edge of the sample (b).

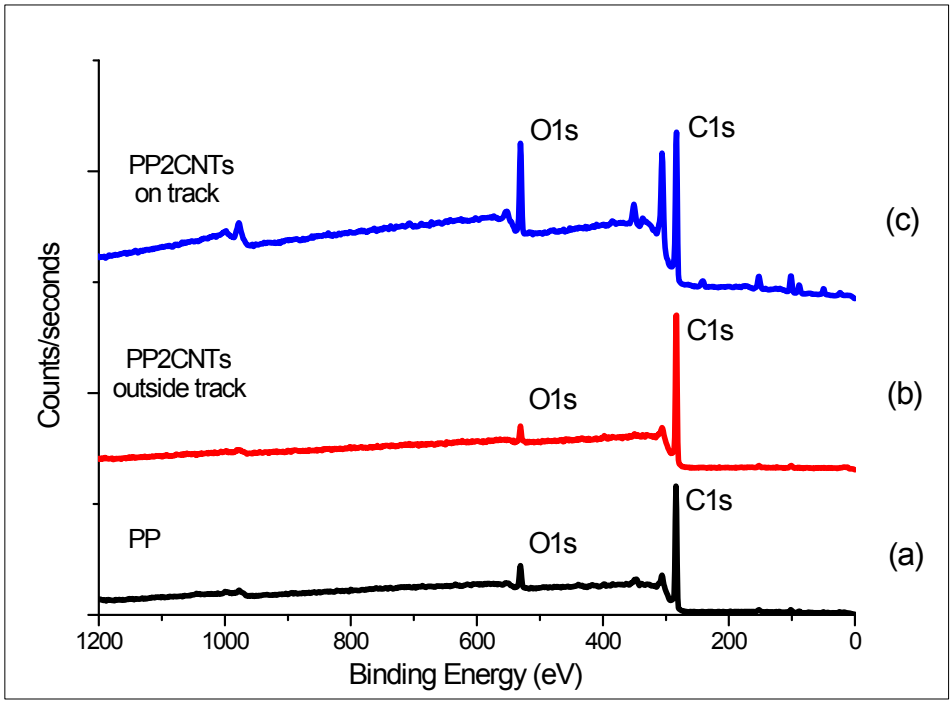


Figure S4. XPS survey spectra after 2 min of Ar^+ sputtering for PP matrix (a) and PP2CNTs nanocomposites outside (b) and inside (c) the conductive track.

Table S3. XPS results obtained after 2 min of sputtering for PP2CNTs inside and outside the conductive tracks and for PP matrix.

Sample	Element	Atomic concentration (%)	Peak position (eV)	Area (%)	Functional Groups
PP	C1s	86	284.46	97.12	C-C, C-H
			286.01	2.88	C-O
	O1s	8.4	530.93	35.39	Mg-O_X
			532.07	58.95	Si-O_X
			533.42	5.66	C-O
	Si2p	1.7	101.85	100	Si-O_X
	Ca2p	1.4	352.11	-	-
	N1s	1.3	401.08	-	-
	Mg2s	1.1	312.52	-	Mg-O_X
PP2CNTs outside track	C1s	92.6	284.50	97.42	C-C, C-H
			286.03	2.58	C-O
	O1s	4.0	531.95	97.25	Si-O_X
			533.94	2.75	C-O
	Si2p	1.9	101.85	100	Si-O_X
	N1s	1.1	400.01	-	N-Ox
	Ca2p	0.4	352.03	-	$CaSiO_3$
PP2CNTs on track	C1s	67	283.93	8.91	C=C
			284.58	83.57	C-C, C-H
			286.45	6.14	C-O
			288.66	1.37	COO-O, COO-H
	O1s	19.5	533.32	10.16	C-O
			531.16	66.77	Si-O_X
			530.99	15.07	MgOx
	Si2p	6.4	101.85	100	Si-O_X
	Mg2s	4.1	312.74	-	MgOx
	Ca2p	1.9	352.03	-	-
	Ar2p	1.0	-	-	-

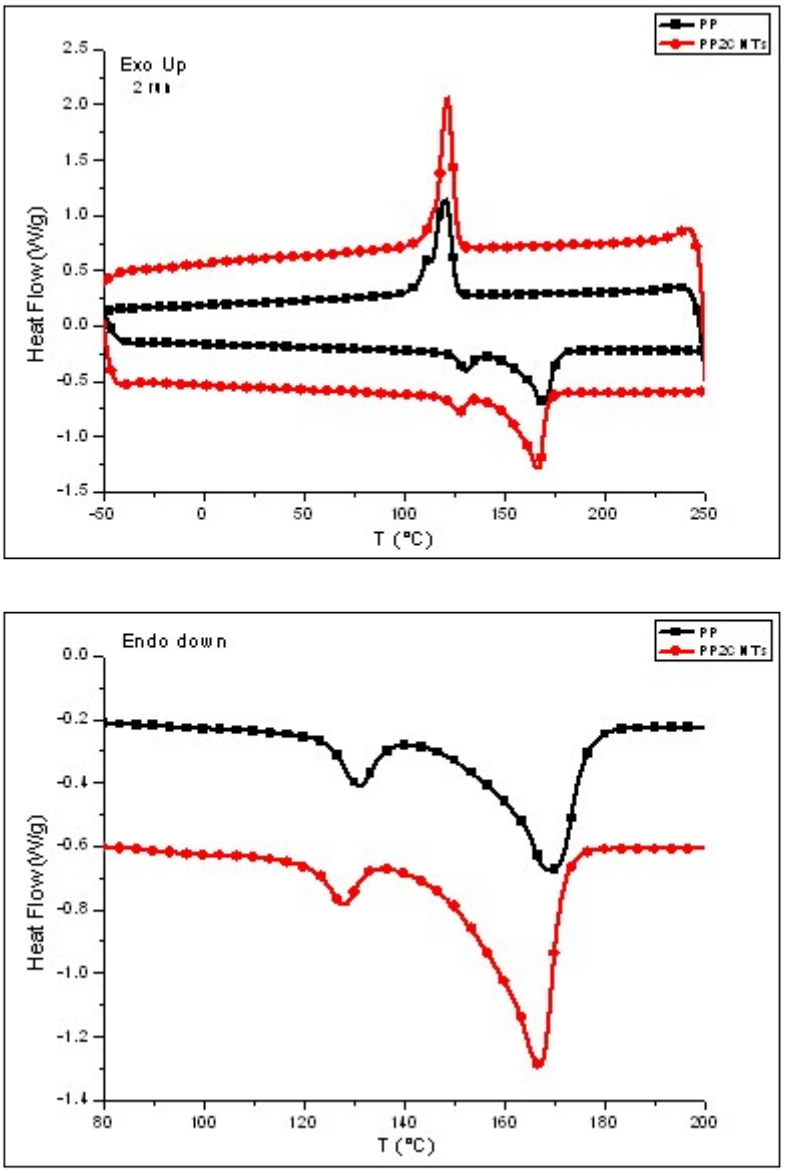


Figure S5. DSC curves, performed in nitrogen, corresponding to the second heating/cooling run (a) and the enlargement of the melting peaks (b) of PP matrix (black curve ■) and of the PP2CNTs (red curve ●) nanocomposites.