Supplementary Information

Multifunctional Nanocomposites between Different Carbon Nanostructures and Styrene Acrylic Latex

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Table S1. Conditions of sample preparation for the SA latex nanocomposites

Sample	Filler type	Nanofiller content / g	Latex / g
SA	–	–	44.50
1SApCNT	*p*CNT	0.2256	43.7
5SApCNT	*p*CNT	11.323	44.98
10SApCNT	*p*CNT	22.334	43.97
1SAaCNT	aCNT	0.2235	44.76
5SAaCNT	aCNT	11.254	44.02
10SAaCNT	aCNT	22.109	45.01
0.5SArGO	rGO	0.0042	1.607
1SArGO	rGO	0.0085	1.623
2SArGO	rGO	0.0155	1.700
5 SArGO	rGO	0.0399	1.612
0.5SAGO	GO	0.0041	1.619
1SAGO	GO	0.0080	1.626
2SAGO	GO	0.0144	1.660
5SAGO	GO	0.0389	1.612

SA: polymer without filler used as a control sample; SAaCNT: nanocomposites with aCNT; SApCNT: nanocomposites prepared with pCNT; SAGO: nanocomposites prepared with graphene oxide; SArGO: nanocomposites prepared with reduced graphene oxide. The number preceding the abbreviation represents the amount of the filler (in weight percent of the dry polymer) added to the composite.

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As can be seen in Figure S1, the spectra of all carbonaceous species present the characteristic bands of sp^2-based carbon nanostructures: the G band at approximately 1580 cm^{-1}, associated to the symmetric stretching vibrations of C–C in the plane; the D band at approximately 1330 cm^{-1}, due to the presence of defects in the sp^2 structure or to the edge effects; and the 2D band at approximately 2655 cm^{-1}, an overtone of the D band related to the two-dimensional structural organization on the plane of the graphene sheet.[1] The spectrum of SA shows characteristic bands of the monomers, styrene and butyl acrylate. The spectra of the nanocomposites present bands of both components, filler and polymer. Figures S1a and S1b show redshifts in the CNT-bands in the spectra of the nanocomposites, resulting from the effective interaction between the CNTs and the polymer. The shifts of the G band (as shown in Figure S1c), for these nanocomposites up to 6 cm^{-1}, is attributed mainly to compression forces of the polymer on the CNTs. This compression is dependent on the nature of the polymer used. In thermoplastic polymer composites these shifts can easily reach 20 cm^{-1}.[2]

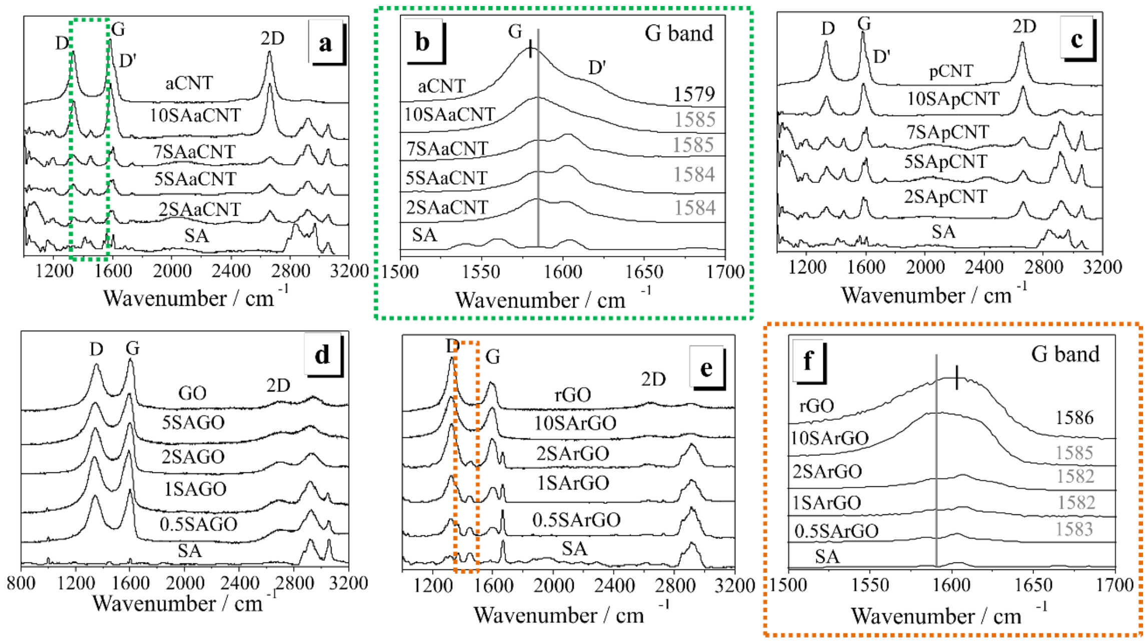

Figure S1. Raman spectra of SA pure and nanocomposites (a,b) SAaCNT, (c) SApCNT, (d) SAGO and (e,f) SArGO. (b) and (f) are expanded spectra between 1500 and 1700 cm^{-1}, taken from Figures S1a and S1e, respectively.

In the case of nanocomposites with graphene species (Figures S1d and S1e) shifts were also observed, however, differently of the CNT nanocomposites to smaller wave numbers (as shown in Figure S1f), indicating a strain of the sheets.[3,4] Especially in the case of two-dimensional materials such as GO and rGO besides this tensile strain which might be acting on these materials, other factors affect the relationships and positions of the bands, such as the nature of the interaction with the substrate or the medium in which the sheet is present, the presence of molecules on their surface, among others. Therefore the presence of this kind of observation in the Raman spectra suggests a good adhesion between the polymer and the filler materials.

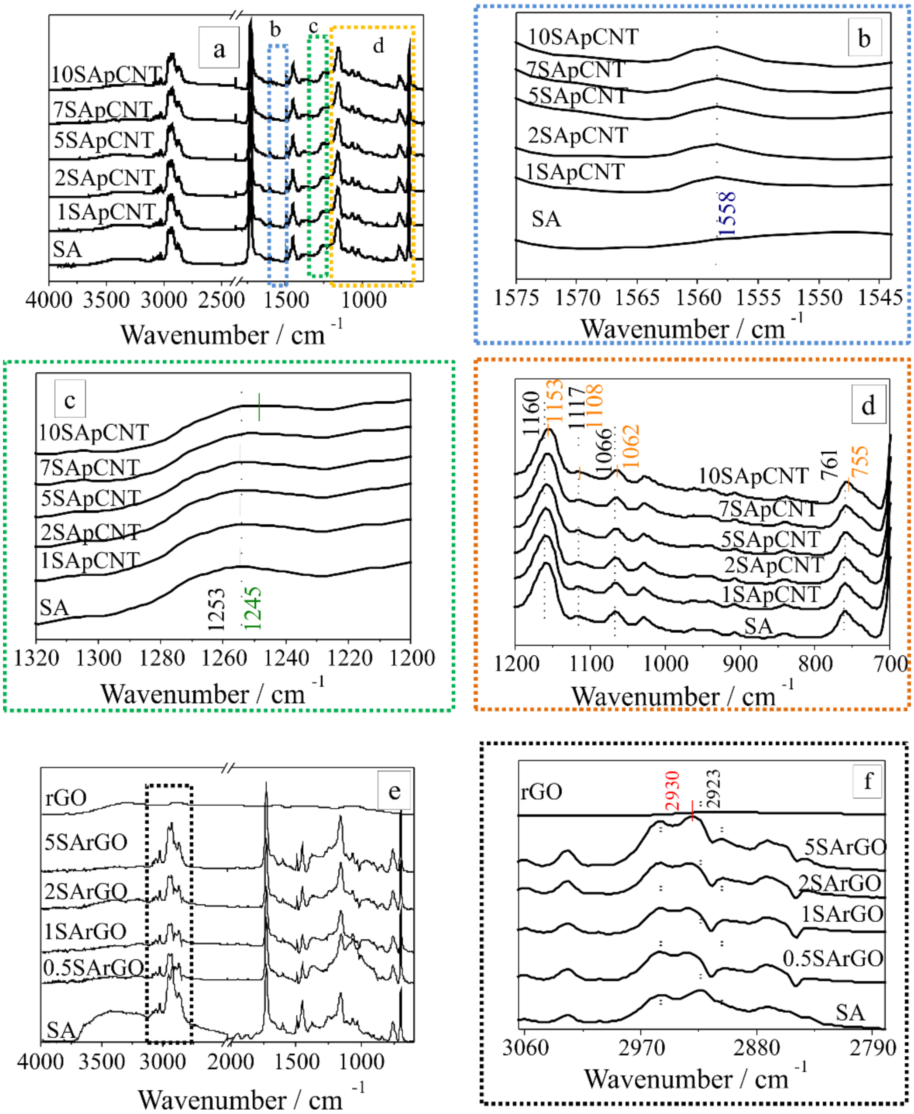

Figure S2. FTIR-ATR spectra of SA and nanocomposites (a-d) SApCNT and (e-f) SArGO.

Table S2. Percentage of swelling of xylene after one hour of experiment

Sample	Swelling after 60 min / %
SA	877 ± 101
1SApCNT	836 ± 87
5SApCNT	691 ± 112
10SApCNT	632 ± 109
1SAaCNT	826 ± 46
5SAaCNT	784 ± 132
10SAaCNT	715 ± 22
1SArGO	848 ± 45
2SArGO	451 ± 60
5SArGO	199 ± 45
1SAGO	341 ± 12
2 SAGO	286 ± 68
5 SAGO	166 ± 47

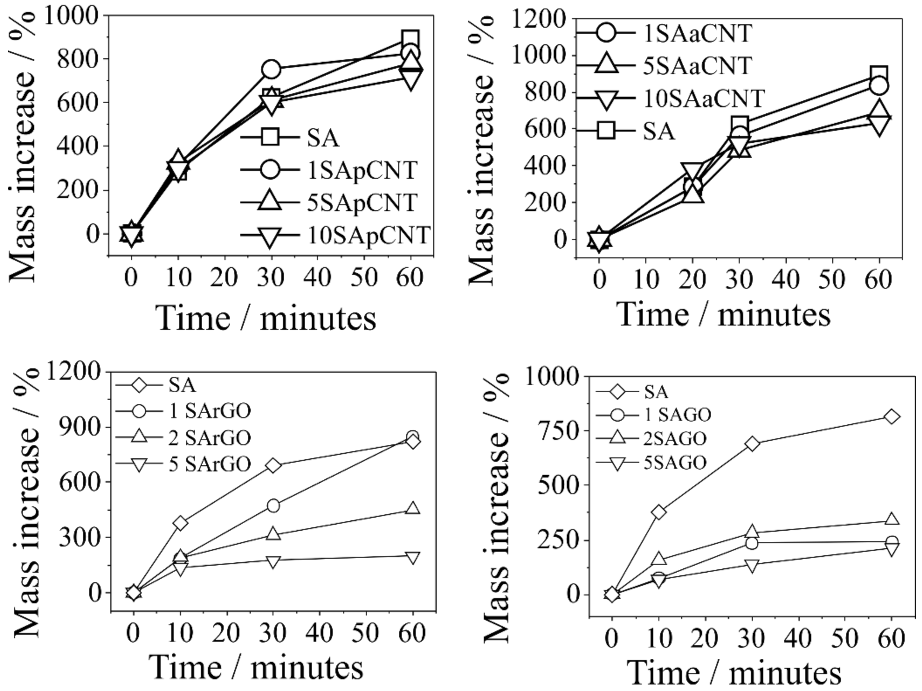

Figure S3. Swelling curves of xylene for SA and nanocomposites (a) SApCNT, (b) SAaCNT, (c) SArGO and (d) SAGO.

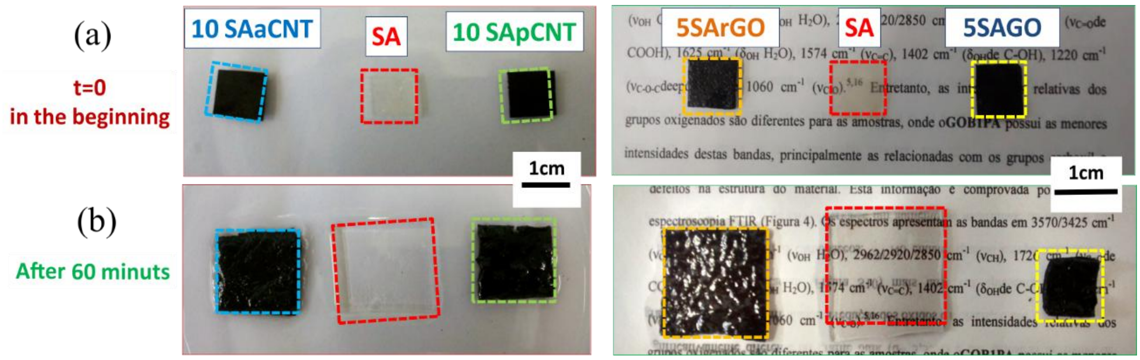

Figure S4. Photographic images of xylene sorption for SA and nanocomposites SApCNT, SAaCNT, SArGO and SAGO in the beginning (t = 0 min) and after one hour (t = 60 min) of experiment.

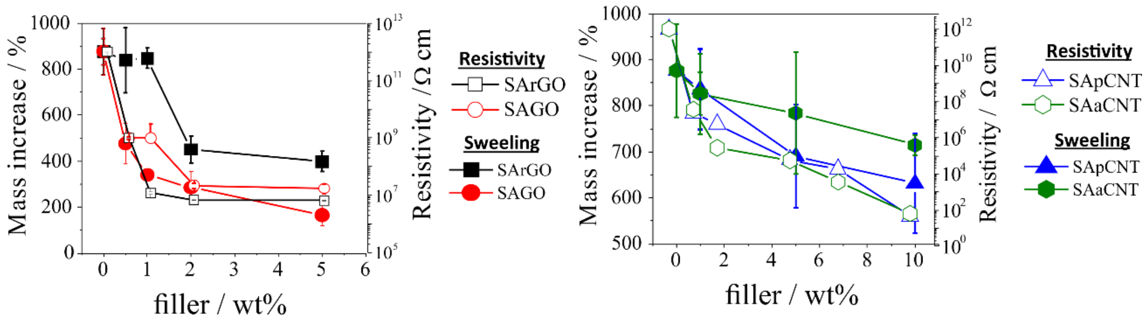

Figure S5. Overlap of electrical resistivity and swelling curves for: (left) SArGO and SAGO (right) SApCNT and SAaCNT samples.

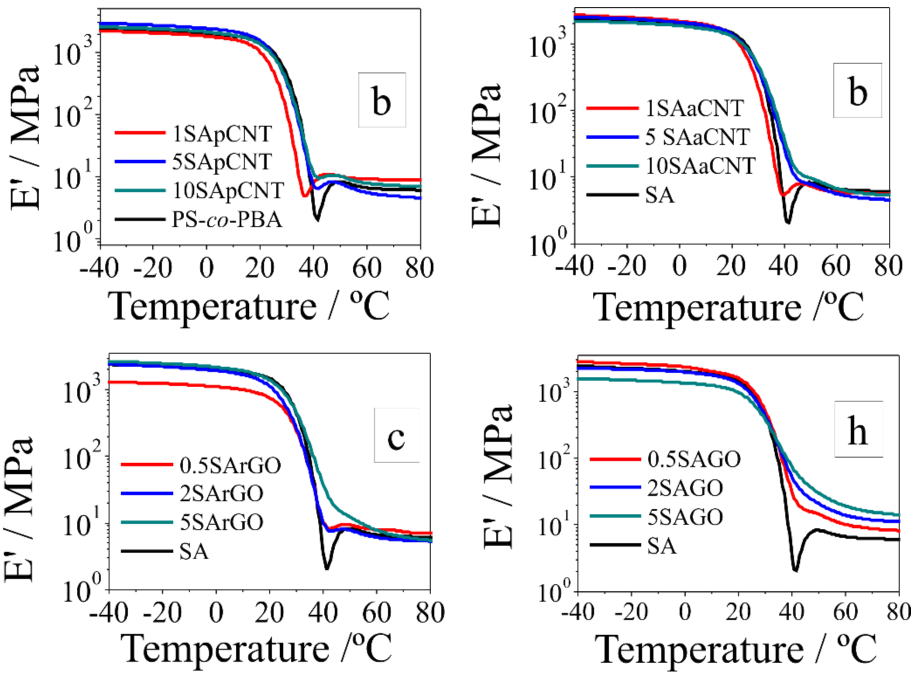

Figure S6. Storage modulus as function of temperature for SA and nanocomposites (a) SApCNT, (b) SAaCNT, (c) SArGO and (d) SAGO.

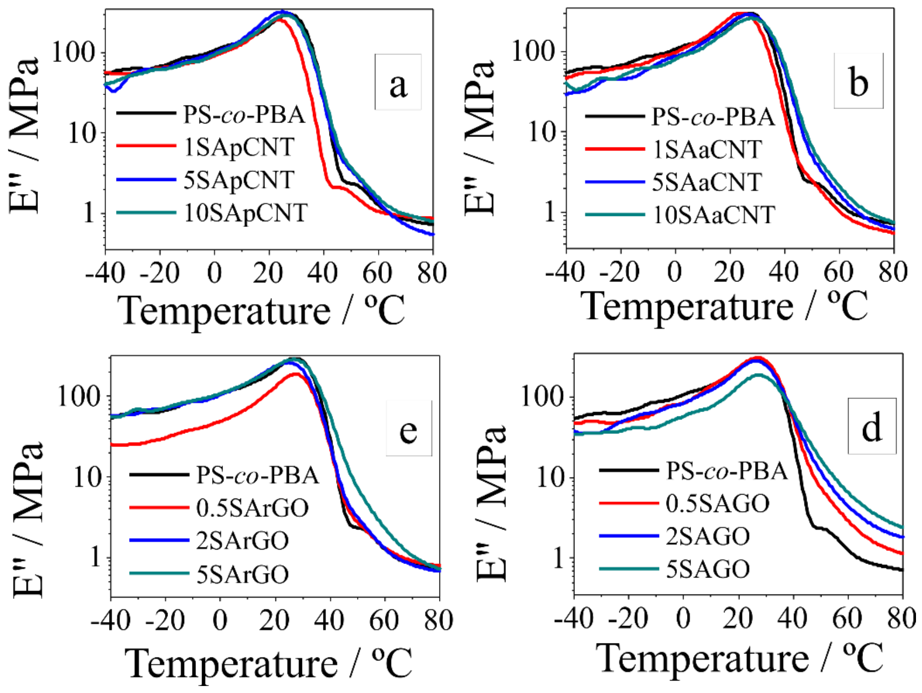

Figure S7. Loss modulus curves for SA and nanocomposites (a) SAaCNT, (b) SApCNT, (c) SArGO and (d) SAGO.

References

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