Manipulating selective dispersion of reduced graphene oxide in polycarbonate/nylon 66 blend nanocomposites for improved thermomechanical properties

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Swelling Analysis

When a polymeric substance placed in an appropriate solvent, either it dissolved completely or will absorb a percentage of the solvent and subsequently get swelled[1-3]. The swollen portion of polymeric materials can be categorized as a solution, although it is predominantly an elastic materials rather than a low viscous solution[2-3]. The percentage of swelling (due the absorption solvent) represents a competition between two forces and these can be calculated by well known equation [1-2]. The free energy of mixing will cause the solvent to infiltrate and try to absorb on the surface polymeric chain. That is why as the polymeric materials placed in suitable solvents the crosslinked network of polymer chains begin to recoil under the swelling action of the solvent molecules consequently a significant deformation appears on the internal and external morphology of polymeric materials[2-3]. In the simplest way for swelling measurements of our polymeric materials we have placed approximately same amount of each materials (pure polymers, neat blends and PNCs) in three most destructive solvents (in 25 ml) for 48 hours. These solvents are formic acid, chloroform and acetic acid and well known to badly penetrate

and damage nylon 66 and polycarbonate within few hours. After the 48 hours we have find out the conclusion regarding the extent of absorption of solvent molecules on the polymeric samples through the weight measurement (**Table S1-S3 and Figure S1**).

Table S1: Weight of samples before and after 48 hours in aqua acetic acid solution

S.N	Samples code	Weight of samples before the swelling (in gram)	Weight of samples after the swelling (in gram)	Total increase in weight of samples
1	N	0.3008	0.30084	0.0004
2	P	0.3500	0.3889	0.0389
3	PN	0.2930	0.2935	0.0005
4	PNG	0.2455	0.2458	0.0003
5	PGN	0.3448	0.3548	0.01
6	NGP	0.3535	0.3535	0.0000

Table S2: Weight of samples before and after 48 hours in Formic acid

S.N	Samples code	Weight of samples before the swelling (in gram)	Weight of samples after the swelling (in gram)	Total increase in weight of samples
1	N	0.3226	0.3846	0.062
2	P	0.3408	0.3408	0.000
3	PN	0.2930	0.3406	0.0476
4	PNG	0.2958	0.3008	0.005

5	PGN	0.3448	0.4882	0.1434
6	NGP	0.3548	0.4008	0.046

Table S3: Weight of samples before and after 48 hours in chloroform

S.N	Samples code	Weight of samples before the swelling (in gram)	Weight of samples after the swelling (in gram)	Change in weight of samples
1	N	0.4321	0.4830	0.0509
2	P	0.4177	0.4178	0.001
3	PN	0.3750	0.3250	-0.05
4	PNG	0.4102	0.3759	-0.0343
5	PGN	03755	0.3001	-0.0754
6	NGP	0.3853	0.3854	0.0001

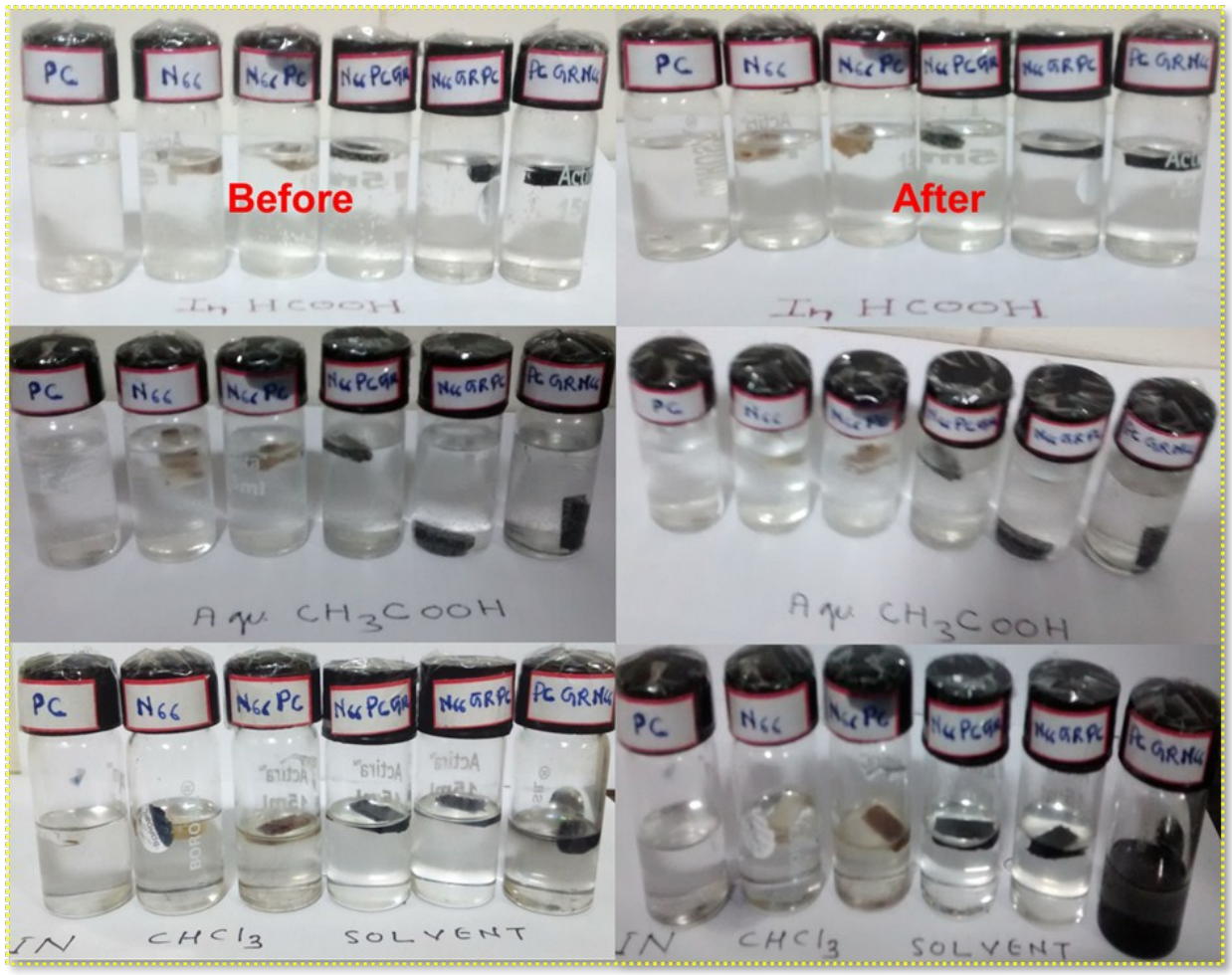

Fig. S1 Photographs of all six samples before and after the swelling analysis

From the given table it is clear the absorption of solvent molecules is negligible in the case of NGP. However, all other investigated materials show a significant swelling when placed for 48 hours in these solvents. The superior solvent resistance capability of NGP is probably due to the very small change in ΔH^0 ΔS^0 value which further governed by the selective dispersion of rGO in nylon matrix.

References

1. **Lange, H., Determination of the degree of swelling and crosslinking of extremely small polymer gel quantities by Analytical Ultracentrifugation. Colloid and Polymer Science. Jun 1986, 1(6):488-93.**
2. **http://www.campoly.com/files/3013/5216/6056/005.pdf**
3. **Durmaz, S., Fank S., Okay O., Swelling and mechanical properties of solution-crosslinked poly (isobutylene) gels. Macromolecular Chemistry and Physics. Mar 2002, 1(4)663-72.**