UNSATURATED POLYESTER-BASED HYBRID NANOCOMPOSITE

Morteza Ahmadi[a], Mohammad Reza Moghbeli[a], Mahmood M. Shokrieh [b]

[a]*School of Chemical Engineering, Iran University of Science and Technology, 16844–13114 Tehran, Iran*

[b]*Mechanical Engineering Department, Iran University of Science and Technology, 16844–13114 Tehran, Iran*

(mr_moghbeli@iust.ac.ir)

The excessive ability of unsaturated polyester resin (UP) in meeting end-use necessities has been a consequential motivation in its extensive growth. The low resistance against crack propagation and high volume shrinkage of UP are the most important drawbacks for its widespread applications. The use of layered silicates such as organically-modified montmorillonites (OMMTs) as reinforcement and rubber materials as toughener are approaches to decline the above deficiencies [1-2].

In this research work, unsaturated polyester resin (UP) was reinforced by using an organically modified montmorillonite (OMMT) and toughened with core–shell rubber (CSR) particles. The effects of OMMT and CSR contents on the fracture behavior and tensile properties of UP have been investigated. The results showed that the incorporation of OMMT up to 3 wt% increased the UP fracture toughness (K_{IC}) on some extent, when further addition caused the fracture toughness to reach a constant level (Table 1). Dispersion state of OMMT platelets and CSR particles inside UP matrix were studied by using transmission electron microscopy (TEM) apparatus. TEM micrographs showed a good dispersion of organoclay tactoids with an intercalated structure or partial exfoliation for the UP reinforced by 1 and 3 wt% OMMT (Fig. 1). On the other hand, the addition of 5 and 10 wt% CSR particles to the UP increased the fracture toughness much more than the OMMT enhanced. Locally clustered but globally good CSR particle dispersion inside the UP matrix was observed for toughened UP specimens. Interestingly, a synergistic effect in fracture toughness was only observed for UP hybrid composite contains 1 wt% OMMT and 10 wt% CSR particles, when compared to other reinforced, toughened, and hybrid specimens. In this case, the OMMT platelets act as bridges between small rubber-particle agglomerates, which may accelerate the CSR particle cavitation and plastic deformation inside UP matrix. The incorporation of

OMMT increased Young's modulus and also, decreased the tensile strength of the neat and CSR-toughened UP specimens with increasing the amount of OMMT.

Table 1. Fracture toughness and tensile properties

Code	OMMT (wt%)	CSR (wt%)	K_{IC} ($MPa.m^{1/2}$)	E (GPa)	σ (MPa)
UP	0	0	0.890	2.30	42.70
UPC1	1	0	0.979	2.58	36.70
UPC2	2	0	1.059	2.58	34.60
UPC3	3	0	1.184	2.67	31.60
UPC5	5	0	1.166	2.81	29.46
UPR5	0	5	1.264	2.19	34.60
UPC1R5	1	5	1.224	2.51	34.16
UPC2R5	2	5	1.090	2.53	33.30
UPC3R5	3	5	1.104	2.65	30.74
UPR10	0	10	1.700	2.30	29.46
UPC1R10	1	10	2.189	2.58	32.02
UPC2R10	2	10	1.727	2.60	31.17
UPC3R10	3	10	1.179	2.70	30.74

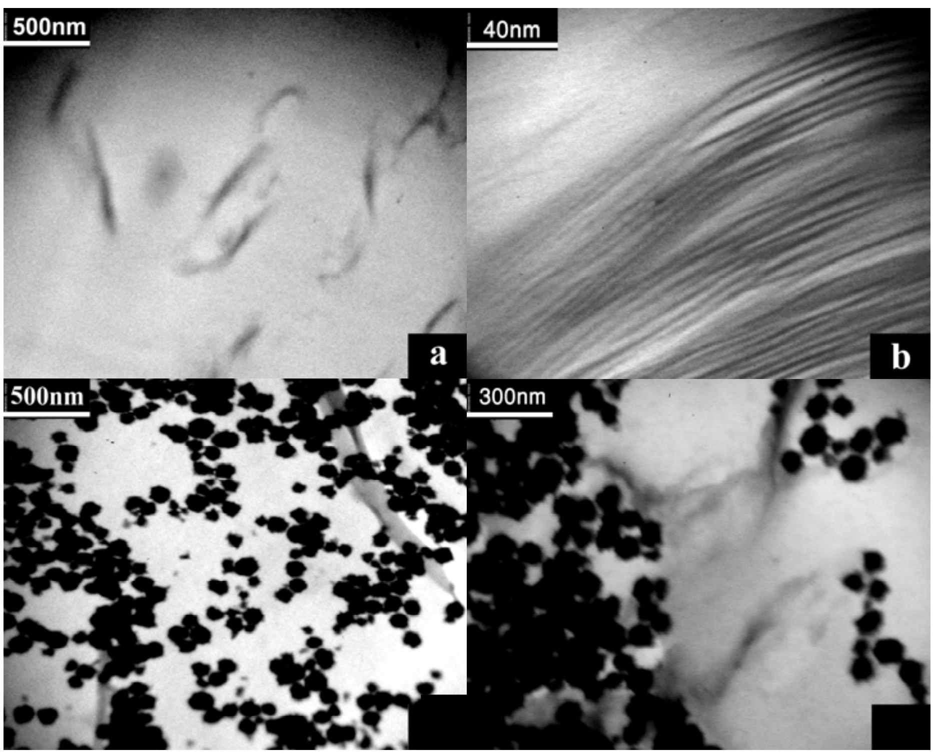

Figure 1. TEM micrographs of: (a, b) 1 wt% OMMT reinforced, (c) 10 wt% CSR toughened UP specimens, and (d) UP/OMMT/CSR hybrid nanocomposite.

References:

1. Xu L., Lee L. J., Polym. Eng. Sci., 45:496-509, 2005.
2. Haq M., Burgueño R., Mohanty A. M., Misra M., Comp. Sci. Tech., 68: 3344–3351, 2008.