Synthesis and Thermo-mechanical Property of Multi-walled Carbon Nanotubes/Poly(methyl methacrylate-co-butyl acrylate) Nanocomposites Prepared Using Emulsion Polymerizations in the Presence of Amphiphilic Random Terpolymer

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Introduction

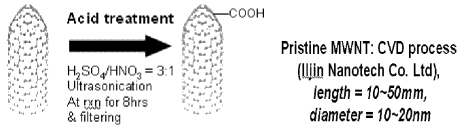
Since Iijima's discovery of carbon nanotubes (CNTs) in 1991(1), single-walled carbon nanotube (SWNTs) and multi-walled carbon nanotube (MWNTs) have attracted much attention because of their unique structural, electronic, mechanic and other properties.(2,3) Some experimental studies on CNT/reinforced polymer materials have been reported for various kinds of organic polymers, including poly-ethylene, poly(methyl methacrylate), polystyrene, and poly-urethane, with enhanced mechanical and electrical properties. In this work, well-dispersible MWNTs were prepared by conventional acid treatment. Dispersion stability of MWNTs was increased by using alkali-soluble resin and *in-situ* emulsion polymerizations of methyl methacrylate (MMA) and *n*-butyl acrylate (BA) were carried out to prepared MWNT/poly (MMA/BA) nanocomposites (4-6).

Experimental

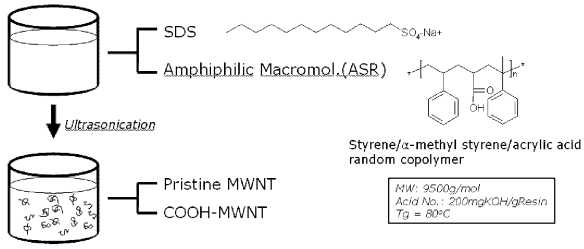
1.1. Preparation of MWNT Aqueous Dispersions

Several MWNT aqueous dispersions were prepared with two types of MWNTs and two kinds of surfactants. For each experiment, 1g of surfactant (each SDS and ESI-REZ 50), 0.009, 0.018, 0.027g of MWNT (each pristine, COOH-MWNT), 300g of DDI water, and calculated amount (for 100% neutralization) of NaOH were used. The resulting mixture was then ultrasonicated by using a horn-type ultrasonicator (Sonic Vibracell, VCX 750). The frequency and power were 20 kHz ± 50 Hz and 40 W, respectively.

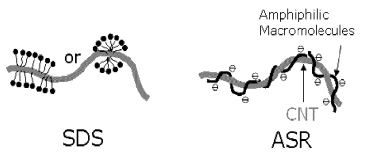
Surface modification of MWNTs



Preparation of MWNTs Dispersions



Detailed structure of surfactants



1.2. Emulsion Polymerizations of MMA/BA in the Presence of Surface-modified MWNTs

Basic Recipe for the emulsion polymerization of MMA/BA

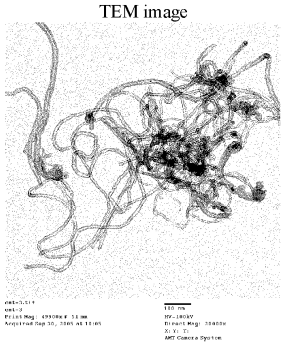
Sample ID	MWNTs / Amounts(g)	MMA / BA (g)	SLS / ASR (g)	KPS (g)	DI water (g)
P1	Pristine MWNT / 0.009g	18 / 12	1.0	0.3	300.0
P2	Pristine MWNT / 0.018g	18 / 12	1.0	0.3	300.0
P3	Pristine MWNT / 0.027g	18 / 12	1.0	0.3	300.0
C1	COOH-MWNT / 0.009g	18 / 12	1.0	0.3	300.0
C2	COOH-MWNT / 0.018g	18 / 12	1.0	0.3	300.0
C3	COOH-MWNT / 0.027g	18 / 12	1.0	0.3	300.0

Notes:
1. Total polymerization time was 300min and reaction temperature was 60oC.
2. The number of reaction was twelve because two type of surfactant.

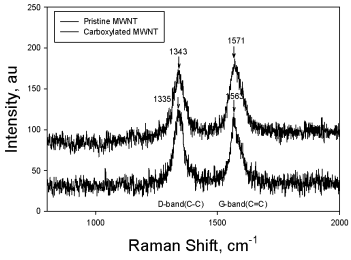
Results and discussion

Surface modified MWNTs : Carboxylated MWNT

TEM image

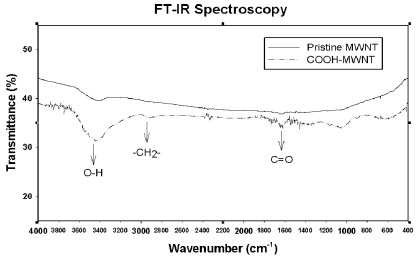


Raman Spectroscopy



The G/D band ratio was slight reduced from 1.0 to 0.9 after the acid treatment, which showed defects of graphite structure of carbon nanotube. The yield of COOH-MWNT was 93%.

FT-IR Spectroscopy



Summary

The carboxylated MWNTs were successfully prepared by conventional acid treatment, and their structures were confirmed by FT-IR, Raman and TEM analysis. The water-dispersibility of the surface modified MWNTs were good. The COOH-MWNT will show better stability during the emulsion polymerization as compared with Pristine MWNT. *In-situ* emulsion polymerizations of methyl methacrylate (MMA) and *n*-butyl acrylate (BA) were carried out. Aggregate size and dispersion stability of the CNTs in water phase were measured using dynamic light scattering, turbidity, UV-visible spectrophotometer, and electron microscope. In addition, thermo-mechanical properties of MWNT/polymer nanocomposites were investigated.

References

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