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Mechanical significance and characterization of CR/EPDM based nanocomposite filled with halloysite nanotube

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ABSTRACT

The current investigation is aimed to originate nano composites based on binary bland of chloroprene rubber (CR) / ethylene propylene diene monomer (EPDM)reinforced with halloysite nanotubes. Nanocomposites have been develop with help of two roll mill with varying amounts of halloysite nano-tubes.The mechanical properties of the originated nanocompsites have been determined by Universal Testing Machine (UTM).Mechanical properties results demonstrate that there is appreciable enhancement in tensile strength ,tensile modulus ,hardness etc. The maximum tensile strength has been achieved at 2phr loading of HNT's in rubber matrices .This may be attributed to good dispersion of HNT's over the entire matrix surface. Thermo-gravimatric analyzer (TGA) has been used to assess the thermal stability of originateed nanocomposites .TGA results demonstrate maximum stability of originated nanocomposites at 2phr loading of HNT's in rubber matrices **.**

Keyword :-Chloroprene rubber , EPDM, Halloysite nano-tube , Tensile strength, TGA .

RESULTS AND DISCUSSION

1.1 MECHANICAL PROPERTIES

The tensile properties of blends are summarized in the Table (1.2). There is remarkable increase of tensile strength, tensile modulus and flexural strength of CR/EPDM rubber blend with incorporation of HNT. But the improvement is more prominent in case of 2phr HNT loading in polymer matrices as compared to virgin CR/EPDM rubber blend. HNT increase the tensile strength of CR/EPDM rubber about 4Mpa. When compared with virgin polymer blend system. Mechanical properties of origination of nanocomposite are higher than the pure matrix to the filler. Effective stress transfer between polymer and fillers depends on the interfacial interaction between the *polymer* and *fillers* and *dispersion of filler* in the polymer matrix. The slippage at filler–polymer interface, due to long strain will decrease the stress transfer efficiency. In case of 2phr loading of HNTs reduce the slippage in the polymer filler interface (under tensile strain) which might to be the reason for the enhancement of mechanical properties of originated nanocomposite at 2phr loading of HNTs nano filler. It has been also observed that the hardness increase of HNT contain in the blend system. This may be due to the cross link density.

TABLE:-1.1

Compounding formulations of cr/epdm reinforced with different loading of HNTs

Sample Code	Epdm (gm)	Cr (gm)	Hnts (gm)	Steric Acid(gm)	Zno (gm)	Sulfur (gm)	Mbt (gm)	Tmtd (gm)
A	70	30	0	2	4	1	1	0.5
B	70	30	1	2	4	1	1	0.5
C	70	30	2	2	4	1	1	0.5
D	70	30	3	2	4	1	1	0.5
E	70	30	4	2	4	1	1	0.5

Sample code	Tensile Strength N/mm^2	Elongation at break (N)	Hardness (Shore A)
A	1.45	690.93	52.63
B	2.75	578.22	56.40
C	5.12	475.83	60.00
D	2.11	418.21	52.63
E	1.50	375.45	49.52

All formulations are in PHR, Parts per 100 of resin

1.2Mechanicalproperties

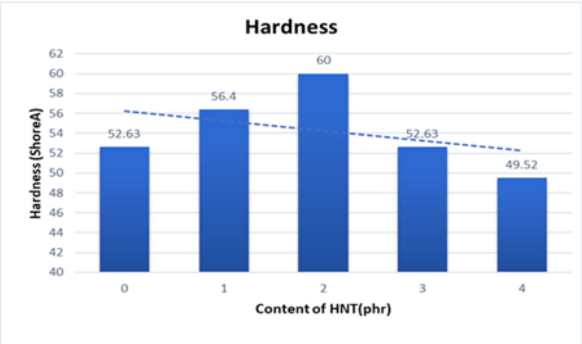

Figure 1.1: Hardness of CR/EPDM reinforced with different loadings of HNT

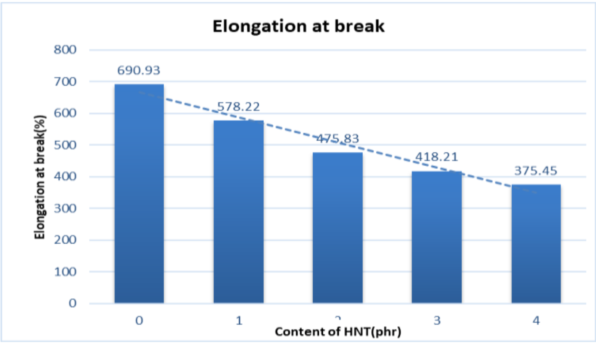

Figure 1.2: Elongation at break of CR/EPDM

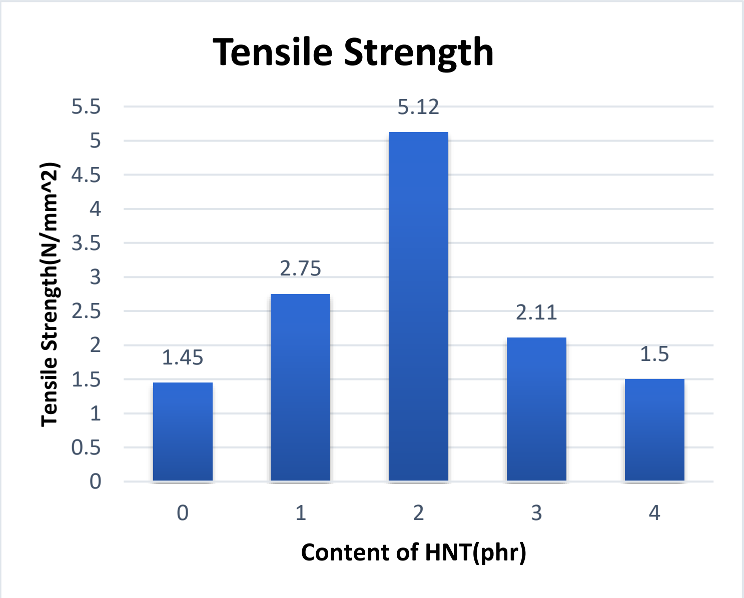

Figure 1.3: Tensile of CR/EPDM reinforced with CR/EPDM reinforced with different loadings of HNTs

1.2 Thermo gravimetric investigation (TGA)

TGA curves of CR/EPDM rubber reinforced with HNT are shown in fig. (1.4) and from table (1.3). It is evidence that maximum thermal stability has been achieved at 2phr loading HNT in CR/EPDM blend system. The incorporation of HNT in CR/EPDM blend systems provided a vast number of restricted site for the polymer matrix are created which constraint the chain mobility and reduce thermal vibration of carbon-carbon bond. Higher amount of energy will be need for the degradation of matrix which is turn increase the thermal stability of nanocompsite. Due to better dispersion of HNTs, the vast number of restricted site will be more in nanocomposites having 2phr loading of HNT in polymer matrix. It is also observed that there is minimum weight loss at 2phr loading of HNT in polymer matrix. Probably due to this reason thermal stability of CR/EPDM rubber reinforce with 2phr HNT is higher than that virgin polymer blend system.

Figure .1.4. TGA graph of CR/EPDM rubber reinforced with different loadings of HNTs

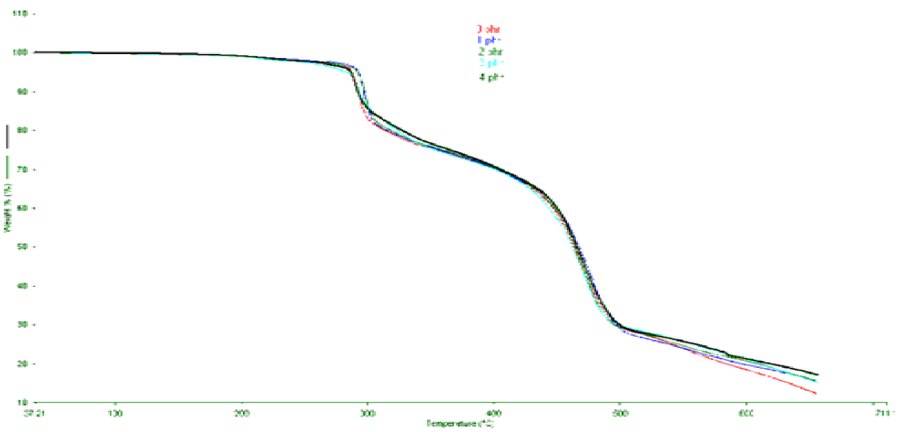

Table 1.3 initial and final degradation temperature of CR/EPDM with HNT

Samples	**Graph curves**
A	0phr
B	1phr
C	2phr
D	3phr
E	4phr

Sample	**Initial degradation temperature in (°C)**	**Final degradation temperature in (°C)**
A	212.34	635.46
B	217.45	652.43
C	239.89	677.45
D	231.36	634.89
E	230.34	633.54

1.3 Scanning electron microscopy (SEM)

The SEM micrography of pure blend and nanocomposites are shown in fig (A,B,C,D,E). The micrograph of pure blend shows the immiscibility and matrix –droplet morphology. Now it can be observed from fig (1.5-1.9) that the average domain size in non-compatibilized binary blend is larger when compared to the other domain size of nano composite. Mainly HNTs , restricted the small droplets remain smaller in size. Larger domain size in pure binary blend might be because of the weak sticking between the two polymers. The reduction in domain size can be attributed to the compatibilitying ability of the HNTs.

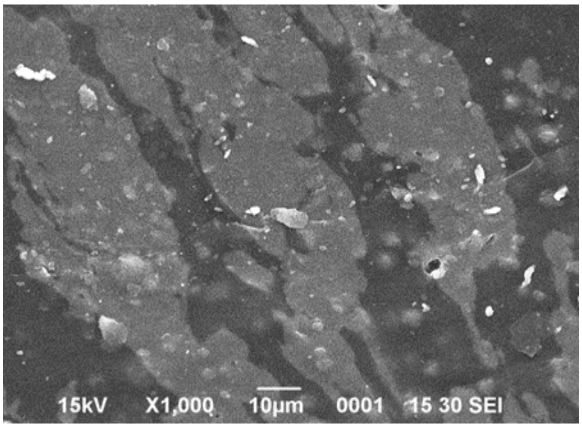

Fig 1.5 CR/EPDM reinforced with 0phr

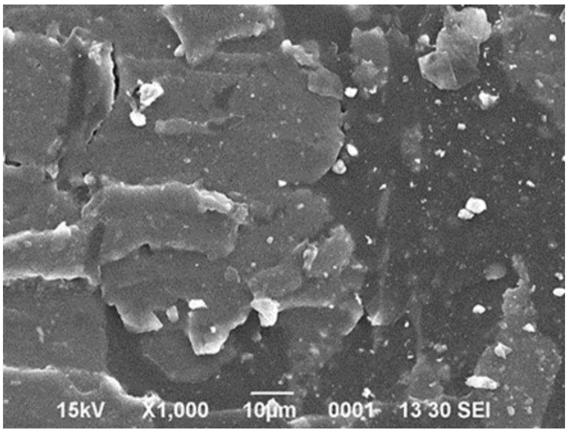

Fig 1.6 CR/EPDM reinforced with 1phr HNT

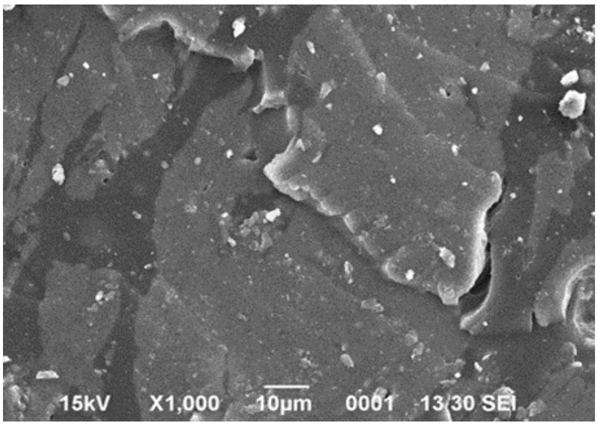

Fig 1.7 CR/EPDM reinforced with 2phr HNT

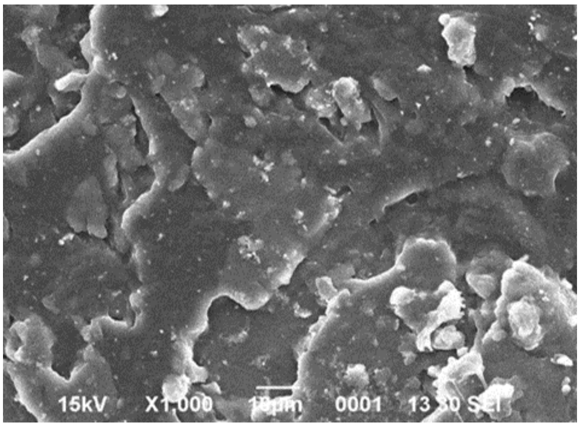

Fig 1.8 CR/EPDM reinforced with 3phr HNT

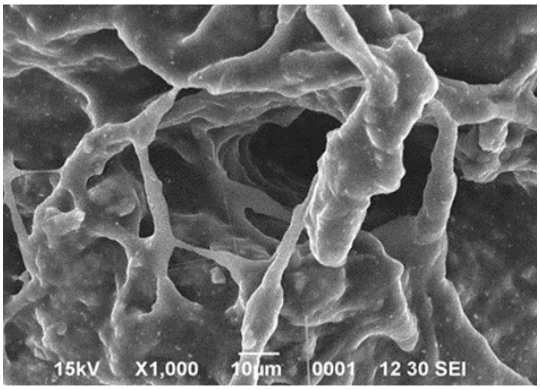

Fig 1.9 CR/EPDM reinforced with 4phr HNT

1.4 CONCLUSIONS

The binary blends of CR/EPDM rubber reinforced with various amount of HNT are develop by melt mixing with the help of two roll mill. And then the specimen sheets are made through the hydraulic press. The effect of modified HNT in the performance of CR/EPDM rubber blends has been investigated in terms of mechanical, morphological and thermal properties. The following conclusions can be inferred from the present investigation:

- The optimum concentrations of modified HNTs is 2phr. Mechanical properties like tensile strength, percentage of elongation at break increase with addition of nano filler and are optimized at 2phr HNT. The trend of these properties was similar. It is observed that tensile strength, elongation at break and hardness are increased until reaching a maximum at HNT up to 2phr.
- TGA examine demonstrate that thermal stability increases appreciably with the incorporation of 2phr loading of HNT into the matrix of CR/EPDM rubber blend.
- SEM examine demonstrate a better dispersion of modified HNT into the polymer matrix, due to better interfacial sticking between HNT and the polymer matrix. The best morphology was also obtained by the addition of 2phr loading of HNT.

Overall results demonstrated that CR/EPDM rubber reinforced at 2phr loading HNT gives better property.

1.5 APPLICATION

- It is also used as a medium for water resistance in electricalcable jointing ,roofing membranes, geomembranes, rubber mechanical goods, plastic impact modification ,thermoplastic, vulcanize,and many others application.
- Blend(CR/EPDM) granuals are mix with polyurethene binders and troweled or sprayed onto concrete as platt screning interlocking bricks,wood etc.
- The most common use however,is probably in vehicles. It is used in door seals windows seals,trunk seals.
- Freqently ,thses seals are the source of noise due to moment of the door against the can body and the resulting friction between the blend(CR/EPDM) rubber and mating surface.
- This can be using spacialty coating that are applied at the time of manufacturing of the weather seal. Such coating can also greatly increase the chemical resistance of blend(CR/EPDM) rubber.