STUDIES ON EFFECT OF MALEATED POLYETHYLENE COMPATIBILIZER ON SOME MECHANICAL PROPERTIES OF KOLA NUT FILLED LOW DENSITY POLYETHYLENE

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ABSTRACT

Some mechanical properties of kola nut filled low density polyethylene (LDPE) have been investigated at filler loadings of 0 to 5 wt. % using 250µm filler particle size. The effect of maleated polyethylene (MAPE) compatibilizer on some mechanical properties of LDPE composites was also investigated . The low density polyethylene composites with or without MAPE were prepared using an injection moulding machine. Results show that the tensile strength at yield, break, and strain of LDPE composites decreased with increases in filler loadings. The addition of MAPE compatibilizer was found to significantly improve the tensile strength at yield, break and strain. However, at higher MAPE contents, these properties decreased .The energy at break, modulus, impact strength, hardness and flexural strength were found to increase with increases in filler loadings and were further improved upon by the addition of MAPE compatibilizer.

Keywords: Filler, Filler Loadings, Low Density Polyethylene, Kola nut, Compatibilizer (MAPE), Composites, Particle Sizes.

INTRODUCTION

Due to the versatile application of plastic products, plastics have been receiving more and more attention. However, problem arises when plastics required to play more stringent roles as engineering materials. The popular inorganic reinforcing component such as glass fibre, is highly costly, therefore, one possible option to reduce the composites production cost is to use organic fillers. This has brought the origin of the product of plastic composites that contains both polymer about the search plastic composites in which organic or inorganic reinforcing materials are used.

There is growing trend in the use of organic filler in the manufacture of polymer composite due to their low density, low cost, nonabrasive nature, possibility of high filling levels, low energy consumption, high specific properties, biodegradability, and availability throughout the world [1-3].

However, companies were sceptical about the use of organic fillers [4] as a result of the sensitivity of the organic fillers to heat and moisture, as well as lack of adhesion between hydrophilic organic filler and hydrophobic polymer raised questions about their usage. Questions about heat and moisture were answered by choosing polymers having the melting temperature lower than the degradation temperatures of organic fillers such as (thermoplastics) and drying of them before or during processing. The other concern regarding adhesion was overcome by improving the similarities between polar organic fillers and non-polar polymer matrices [2]. For this purpose several coupling agents, have been employed [6-8] and maleated coupling agent were found to be the most suitable coupling agent for polyolefin based polymer composites [9].

Different organic fillers and coupling agents have been studied for making low density polyethylene composites. Najafi et al [10] studied saw dust high density polyethylene compatibilized by MAPE and reported an improvement in modulus, and tensile strength. Similarly Yuan [11] who investigated the

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effect of maleic anhydride – grafted-polyethylene on wood filled low density polyethylene reported that addition of MAPE increased the flexural and impact strengths.

(Beside the work reported above). The use of kola nut powder in filling low density polyethylene or any other thermoplastics had not been reported in the scientific literature to our knowledge.

MATERIALS AND METHODS

Materials

The low density polyethylene used in this study was obtained from Indorama Petrochemical Company Limited, Eleme, Rivers State, Nigeria. The low density has a melt flow index (MFI) of 0.4g/min and density of 0.922g/cm^3. The kola nuts were obtained locally from Ezinihitte Mabaise, Imo state, Nigeria. The kola nuts were brought out from the bunch, and later sun dried .They were crushed to fine powder and sieved to 0.25mm mesh size. The compatibilizer (maleic anhydride-grafted-polyethylene) was bought from sigma -Aldrich Cheme GmbH, Germany and was used as received.

Preparation of Polyethylene Composites

The low density polyethylene composites of kola nut using a particle size of 250µm were prepared by thoroughly mixing 200g of low density polyethylene with approximate filler quantities (0,1,2,3,4 and 5 wt. %). The low density polyethylene was first melted and homogenized with the filler in an injection moulding machine at 150^{o}c and the resulting composites were produced as sheets.

In the second set of composites preparations, fixed quantities of LDPE (200g), different filler contents and calculated quantities of maleic anhydride-grafted- polyethylene (0, 1, 1.5,and2.5 wt.%) were measured ,fed into an injection moulding machine, and processed.

Testing

The Tensile strength (ASTM D 638), Modulus (ASTM1822),Energy at break (ASTM D 2563), Impact strength (ASTM D 256), Brinell hardness (ASTM D 785), Flexural Strength (ASTM D 790),Properties of the prepared compatibilized polyethylene composites were determined using standard method

RESULTS AND DISCUSSION

Mechanical Properties

The mechanical properties of low density polyethylene composites prepared in the present study are illustrated graphically in Figures 1-8.

Tensile Strength at yield and at Break:

Figures1&2 show the effect of coupling agent (MAPE) and filler loadings on the tensile strength at yield and at break. It can be seen that the tensile strength at yield and at break of low density polyethylene composite decrease with increases in filler loadings and are all lower than the tensile strength of unfilled low density polyethylene. The decrease in tensile strength at yield and at break with increases in filler loadings is in agreement with the findings of Ismail et al [12]. Similar observation as above was also reported by Rozman et al [13].Also Figure 1&2 show that the addition of small amount of MAPE generally improved the tensile strength at yield and at break of the composite significantly after which additional increases in the amount of MAPE led to decrease the tensile strength at yield and at break of the composites. The increase in the tensile strengths of the composites is believed to be caused by a long continuous chain in maliec anhydride molecules which are compatible with the polymer matrix chain via physical entanglement Felix et al [14]. Further increase in the compatibilizer had little effect on tensile strength at yield and at break. This suggests that there was not much stress transfer from the matrix to the filler irrespective of MAPE content.

Strain at Break

Figure 3 shows that the strain at break of low density polyethylene composites decrease with increases in filler loadings due to the reduction of the deformation of a rigid interface between the filler and polyethylene matrix. Moreover, the strain at break of composites was significantly improved on addition of MAPE compatibilizer and further increase in MAPE reduces the strain at break. Similar observation has been reported by Wirjosetone et al [15]

Energy at break

From figure 4, the energy at break for kola nut low density polyethylene composites increases with increases in filler loading. The use of the compatibilizer MAPE is observed to increase the energy at break of the composites with increases in the compatibilizer contents. Moreover, further increases in compatibilizer increases energy at break .This is as a result of interaction and adhesion between the polymer matrix and filler particle.

Modulus

Figure 5 illustrates the effects of kola nut powder loadings, and compatibilizer on the modulus of prepared low density polyethylene composites. The modulus of the composites increased with increases in filler loadings and compatibilizer contents. This observation highlights the facts that the incorporation of fillers and compatibilizer into polymer matrix improves the stiffness of the composites.

Impact strength

The impact strength of low density polyethylene composites of kola nut at 250µm particle size was observed to increase with increases in kola nut content (Figure 6). Further addition of compatibilizer increases the impact strength. This indicates that the compatibilizer was more effective in distribution of the applied stress over a volume at the base of the notch, and which helped to prevent cracking propagation of cracks by carrying large part of the load in the area under the crack. The increased in impact strength of a polymer composite with increase in filler loadings has been reported in the literature [16].

Hardness

Figure 7 shows that the hardness of all filled low density polyethylene increased with increases in the amount of filler incorporated into the polymer matrix. This result indicates enhancement of abrasion of the composites Chakraberty et al [17]. A general increase in the hardness of LDPE composites with increases in MAPE can be observed in figure 6. The addition of the compatibilizer (MAPE) envisaged increasing the interfacial bonding between the LDPE matrix and the micro structure of the surrounding matrix which leads to increase in composite hardness

Flexural strength

The flexural strength of low density polyethylene composites of kola nut at 250µm particle size was observed to increase with increases in kola nut contents (Figure 8). Further addition of compatibilizer increases the impact strength.

CONCLUSIONS

The tensile strength at yield, tensile strength at break and strain at break of kola nut filled low density polyethylene showed decreases with increases in kola nut powder filler loadings. The addition of MAPE into the composite system was found to significantly improved the tensile strength at yield and at break, and strain at break of the resulting composites .However further addition of MAPE decreases the above properties.

The energy at break, modulus, impact strength hardness and flexural strength of the prepared LDPE composites were found to increase with increases in filler loadings and they were further improved upon by the addition of MAPE compatibilizer to the system.

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FIGURES

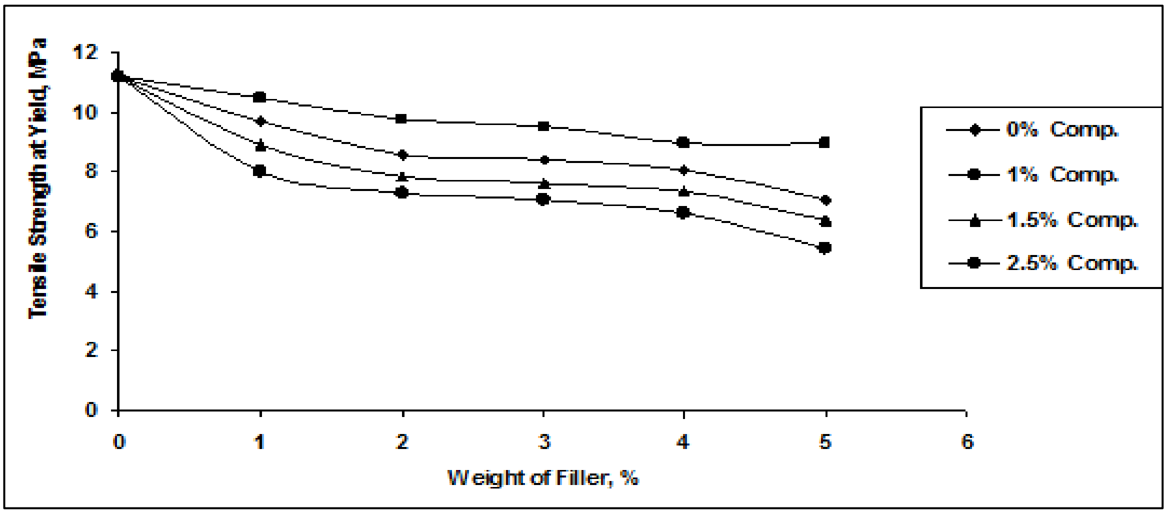

Figure 1: Plot of Tensile Strength at Yield versus Weight of Filler for LDPE/KN Composites at different Compatibilizer content

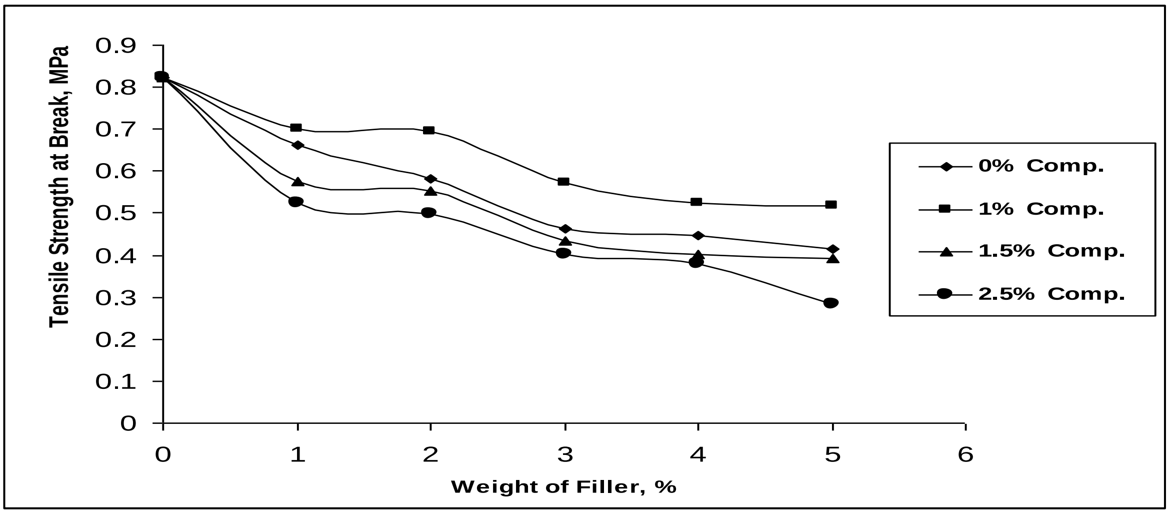

Figure 2: Plot of Tensile Strength at Break versus Weight of Filler for LDPE/KN Composites at different Compatibilizer contents

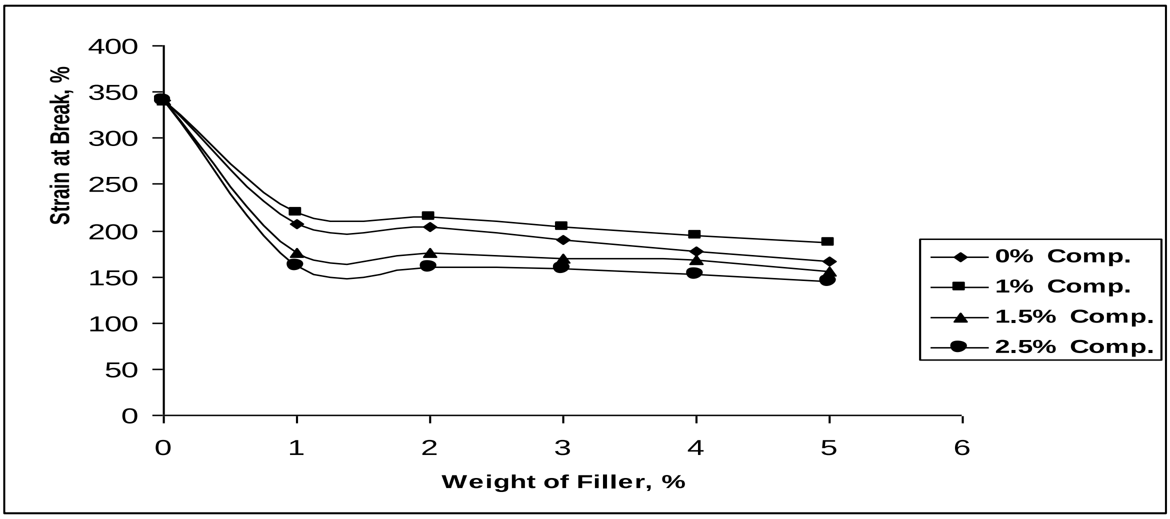

Figure 3: Plot of Strian at Break versus Weight of Filler for LDPE/KN Composites at different Compatibilizer contents

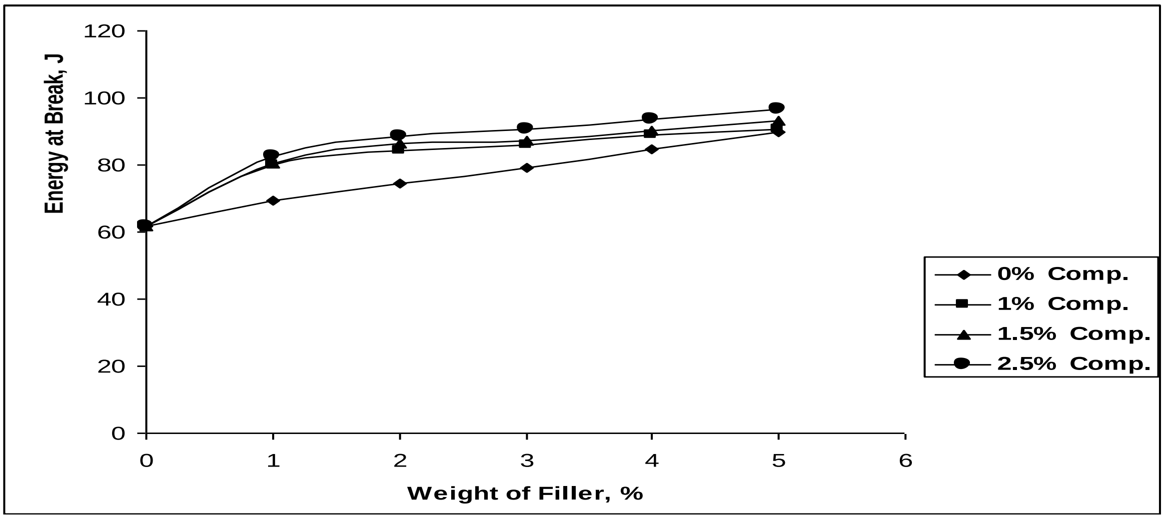

Figure 4: Plot of Energy at Break versus Weight of Filler for LDPE/KN Composites at different Compatibilizer contents

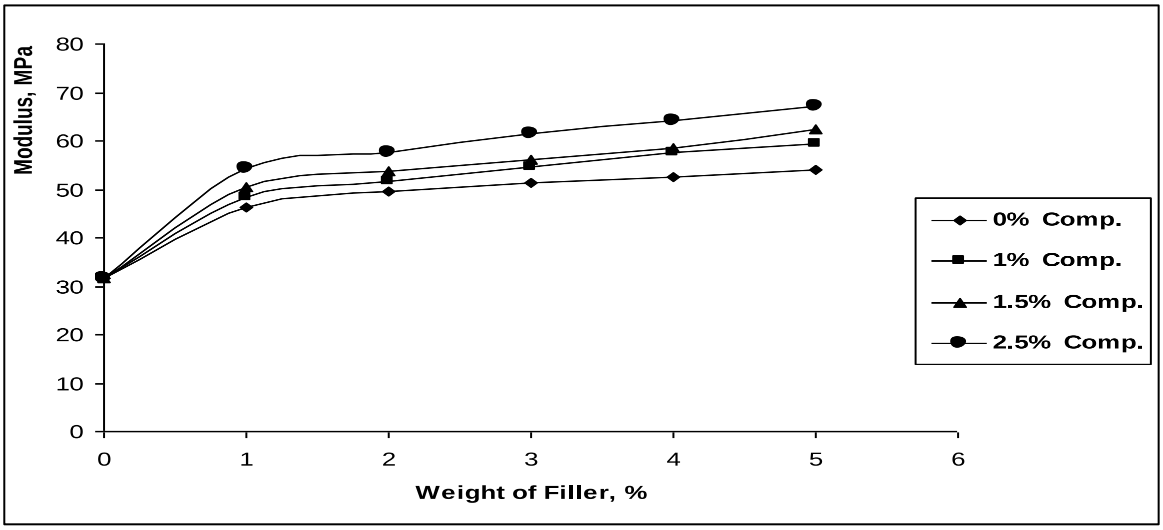

Figure 5: Plot of Modulus versus Weight of Filler for LDPE/KN Composites at different Compatibilizer contents

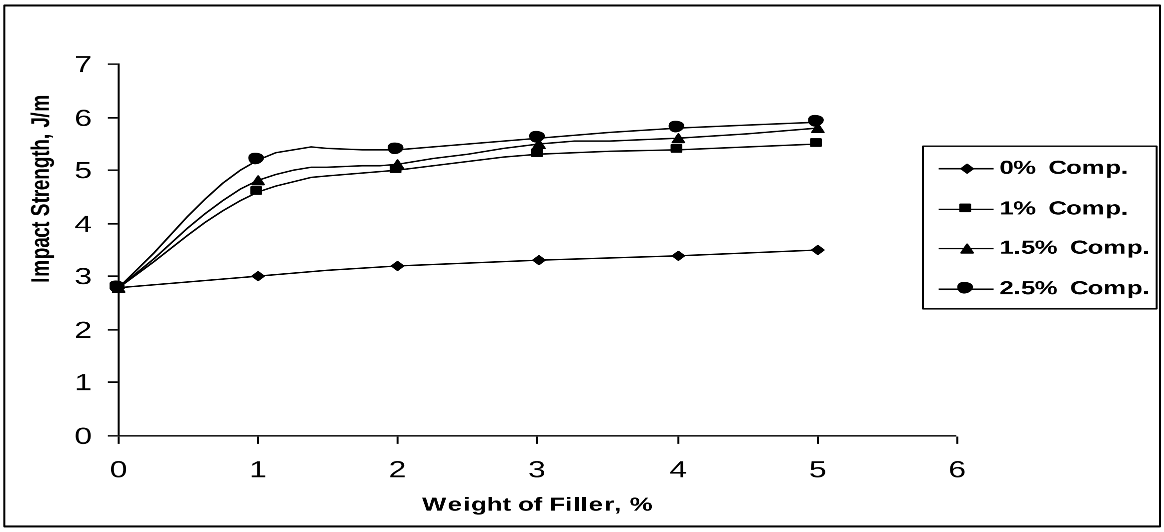

Figure 6: Plot of Impact Strength versus Weight of Filler for LDPE/KN Composites at different Compatibilizer contents

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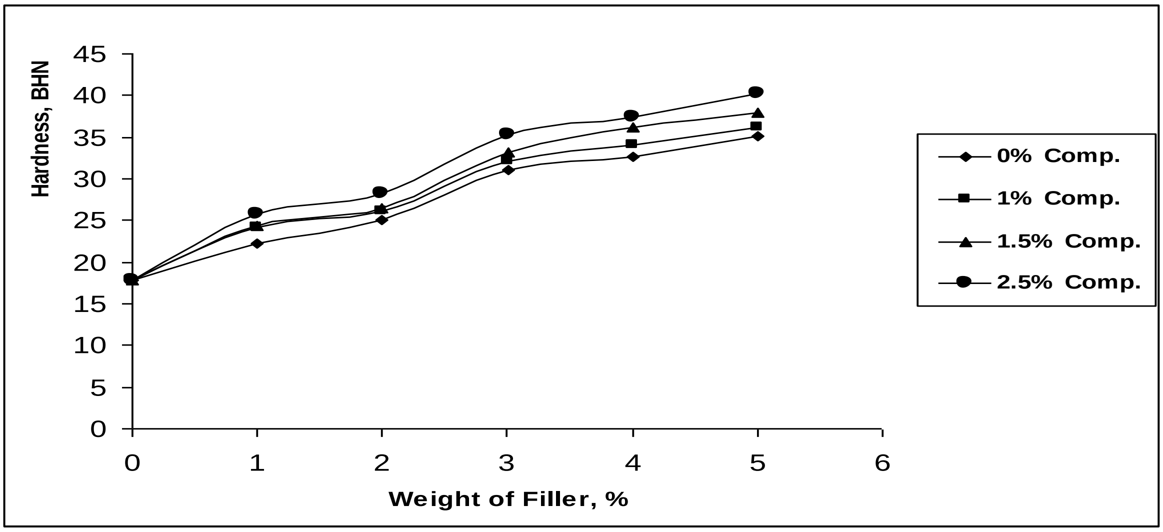

Figure 7: Plot of Hardness versus Weight of Filler for LDPE/KN Composites at different Compatibilizer contents

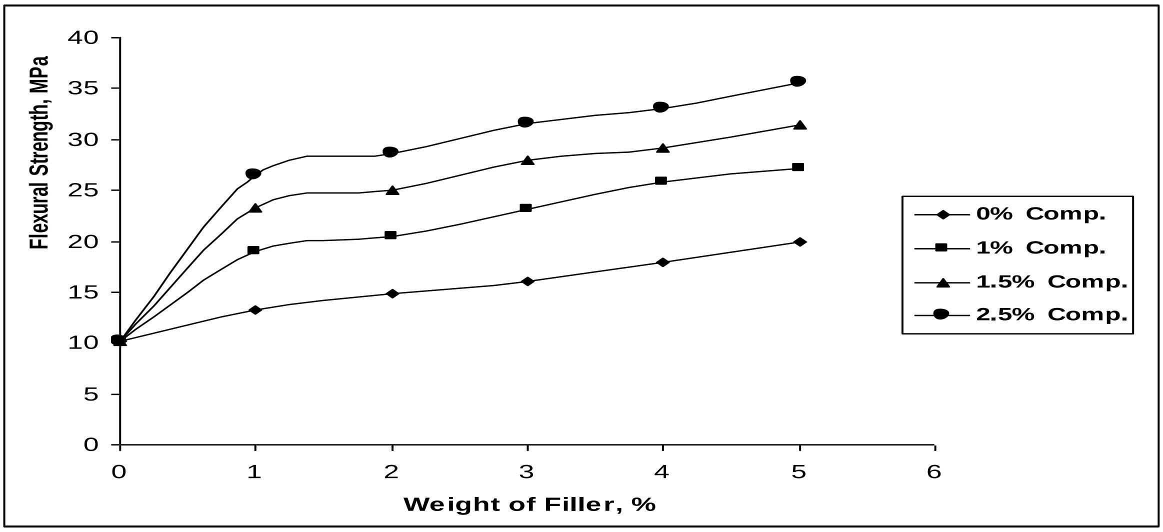

Figure 8: Plot of Flexural Strength versus Weight of Filler for LDPE/KN Composites at different Compatibilizer contents