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EFFECT OF LDPE SCRAP COMPOSITION ON PHYSICAL AND MECHANICAL PROPERTIES OF RECYCLED PVC

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ABSTRACT
Plastic is a versatile and inexpensive material with thousands of uses, but it is also a significant source of pollution. Some worrisome emerging environmental issues involve plastics, including gigantic oceanic garbage parches and the micro beads problem. In an effort to combat these problems most plastics are being recycled today. Two common plastics, Low density polyethylene and Polyvinylchloride, were melt-mixed at different percentages of 10/90 - 50/50% of LDPE / PVC and tested. The sample with 10% LDPE composition showed higher tensile strength, moderate elongation and higher modulus. Results also indicate that the tensile strength decreases as the percentage of PVC is decreased. Sample 40/60 has the highest elongation property, however, samples 10/90 and 50/50 displayed higher modulus. The flexural strength, which is the ability of the specimen to resist deformation, generally decreased as the composition of LDPE was increased with 10/90 sample having highest value of 46.4Mpa.

Keywords: *Polyvinyl Chloride (PVC), Low Density Polyethylene (LDPE), Blending Composition, Tensile Strength, Flexural Strength.*

INTRODUCTION
Plastics are light, durable, mouldable materials obtain from polymers. They are hygienic and economic making them suitable for a wide range of applications in food and product packaging, car manufacturing, agriculture and housing products.
The word plastic is derived from the Latin word "plasticus" (capable of moulding). The first synthetic plastic was discovered in the late 1850's by the

English inventor Alexandar Parkesine, but has only been fully utilised in the last 30 years.. Plastics are made up of long chain molecules called polymers. These polymers are formed from small units called monomers and can be made into granules, powders and liquid, becoming the raw materials for plastic products.

Although plastic is a versatile and inexpensive material with thousands of uses it is also a significant source of pollution. Some worrisome emerging environmental issues involve plastics, including gigantic oceanic garbage parches and the micro beads problem. (Thompson R.C., *et al*, 2009).

Plastics are usually classified by the chemical structure of polymer's backbone and side chains, the chemical process used in their synthesis (such as condensation, poly-addition and cross-linking),by various physical properties and based on the quantities that are relevant for manufacturing or product design (M W, Allsop and G Vianello, 2012).

Basically there are two different type of plastics, which are formed either by Addition or condensation polymerization and they can be divided under two groups, but each type have subtypes. The two groups are thermosetting materials and thermoplastics.

The thermosetting materials when heated, their molecules cross-link with each other and create a permanent, three dimensional networks that can be considered as one giant molecules. After the cross-link the plastic cannot be re-melted.

Thermoplastics however, are plastics that can be repeatedly softened by heating and hardened by cooling. Because they are linear or slightly branched, they do not chemically bond with each other when heated. For this reason, thermoplastic materials are in high demand because they can be repeatedly softened and reused almost indefinitely.

Recycling can alleviate some of the problems, but the confusion over what can be and what cannot be recycled continue to confound consumers.

Plastics are particularly troublesome, as different types require different processing to be reformulated and re-used as raw material (Frederic Beaudry, 2017). While plastic refuse on land is a familiar eyesore as litter and a burden on our landfills, in the marine environment it can be lethal to sea creatures by way of ingestion or entanglement.

Low density polyethylene (LDPE) and linear low density polyethylene (L/LDPE) are two of a class of plastic resins obtained by polymerizing the gas ethylene. LDPE is most often used in packaging where clarity is important. L/LDPE retains its strength at low temperatures and is used for products like ice bags. Unlike bottle resins, most LDPE and L/LDPE is recovered from commercial and industrial facilities. The products commonly recovered include plastic grocery bags, shrink wrap and stretch wrap from commercial and industrial shipping. Polyethylene is the most popular plastic in the world. This is the polymer that makes grocery bags, shampoo bottles, children's toys, and even bullet proof vests

PVC (polyvinyl chloride) is the world's third-most widely produced synthetic plastic polymer after polyethylene and polypropylene (M. W. Allsopp, G. Vianello, 2012). Sometimes known as 'vinyl', PVC is a thermoplastic material made of 57% chlorine (derived from industrial grade salt) and 43% carbon (derived predominantly from oil / gas via ethylene). It is inexpensive to make, requires minimal maintenance when in use, and is extremely durable (it is commonly used to make long-lasting products, often with a life-expectancy exceeding 60 years. PVC products are well suited for recycling when they come to the end of their life.

There are two principal ways of recycling PVC; Mechanical recycling and Feedstock recycling (Madalina Elena Grigore, 2017)

The paper aims to study the effect of LDPE scrap on the properties of the recycled PVC.

MATERIALS AND METHODS

The materials used for blending and moulding the PVC/LDPE mixture were all obtained locally. They include Polyvinylchloride (PVC) from pipe scraps, Low density poly ethylene (LDPE) from table (Pure) water sachets, Shredding machine, Two roll mill (compounding) machine, Compression moulding machine, Processing oil, Mould, Foil paper, Hand glove, Hack saw.

METHODS

Preparation of PVC and LDPE

The PVC scrap (pipe) material was cut and then grinded until it became powdered. The LDPE (sachets) picked from the surrounding was washed and dried for 2 hours then grinded to become crystal like.

Blending processes

The two roll mill (compounding) machine at the Nigerian Institute of Leather Science and Technology (NILEST, Zaria was used for blending the samples, it consist of two rolls and temperature panel.

The temperature was first set at 160^{O}C within 5-7 minutes. PVC was used as a filler because it is in powdered form. Therefore 10% of LDPE was first introduced to the machine, melted and wound on the rollers while spreading the 90% PVC powder on the melted LDPE. The knife was used to cut-off the blended sample. The blending was carried out as in table 1 below.

TABLE 1: % of Blending Composition

%LDPE	10	20	30	40	50
%PVC	90	80	70	60	50

Molding Processes

The compression molding machine was used. The material from two roll mill machine was inform of sheet which was also cut with hack saw according to the mould size 3 mm^2. Oil was applied on internal sides of the mould for safe and easy removal. The machine was set to 150^{O}C and the sample was introduced to the machine for 5minutes then removed and dried for 3-5 minutes.

Tensile Strength Test

All tests were carried out at the Department of Mechanical Engineering, Ahmadu Bello University Zaria on MONSANTO TENSOMETER, TYPE "W"S/N - 9875, MADE IN UK.

The tensile test was performed until tensile failure occurred. Tensile property was determined for three different specimens of each sample composite and an average of replicate of the tested specimens were presented.

The method determines the tensile properties of the composite based on the stipulated conditions of temperature and speed of the testing machine.

Flexural Strength Test

The samples were cut into rectangular specimens and tested for bending property of the composite.

RESULTS AND DISCUSSION

Tensile Test

Tensile strength measures the force required to pull the specimen or a structural beam to the point where it breaks (Braunecker and Matyjaszewski, 2007). Tensile strength is the load per unit area of the original cross – sectional area at any given moment. The maximum tensile stress during the test is called the tensile strength of the materials.

FIG.1: Tensile strength

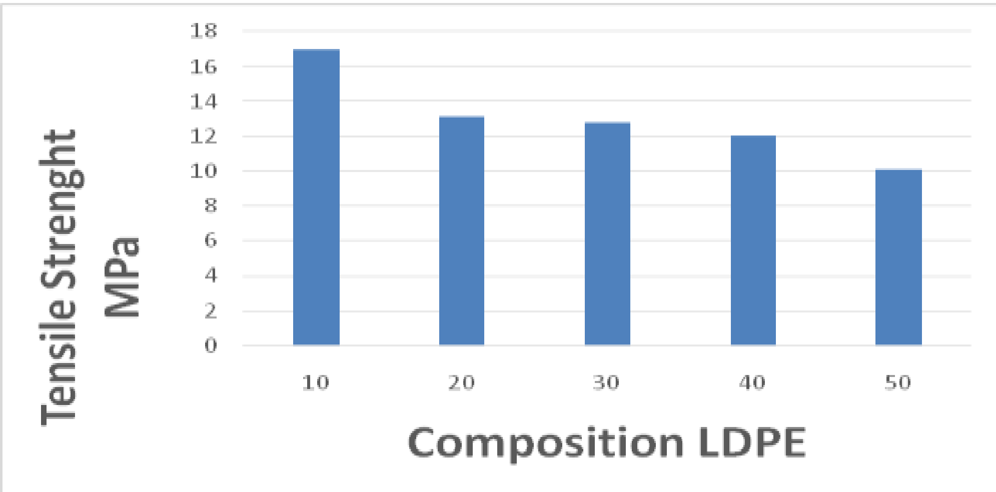


FIG.2: % Elongation

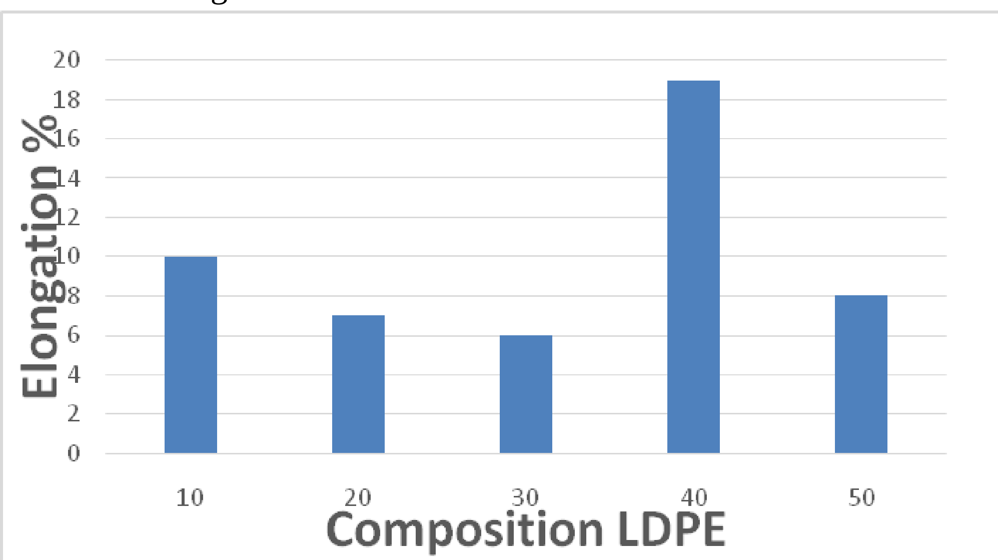
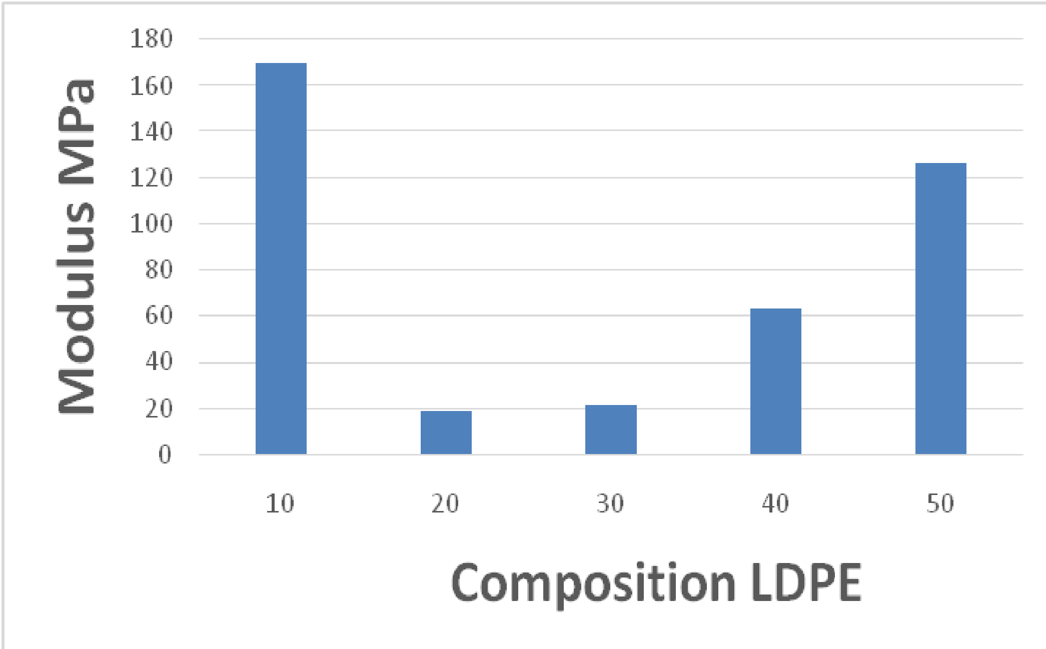


FIG.3: Modulus



The sample composition of LDPE 10% has higher tensile strength, moderate elongation and higher modulus. The results indicate that tensile strength is reducing with decrease in the percentage of PVC. Sample 40% s has the higher elongation property. However samples 10% and 50% show higher modulus.

FIG. 4: Flexural strength

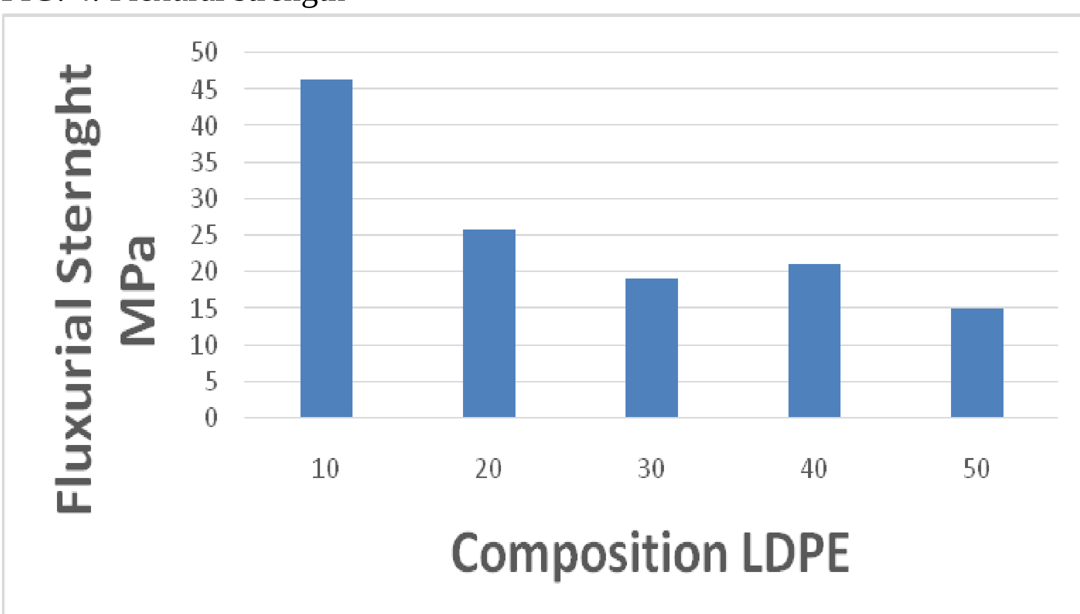
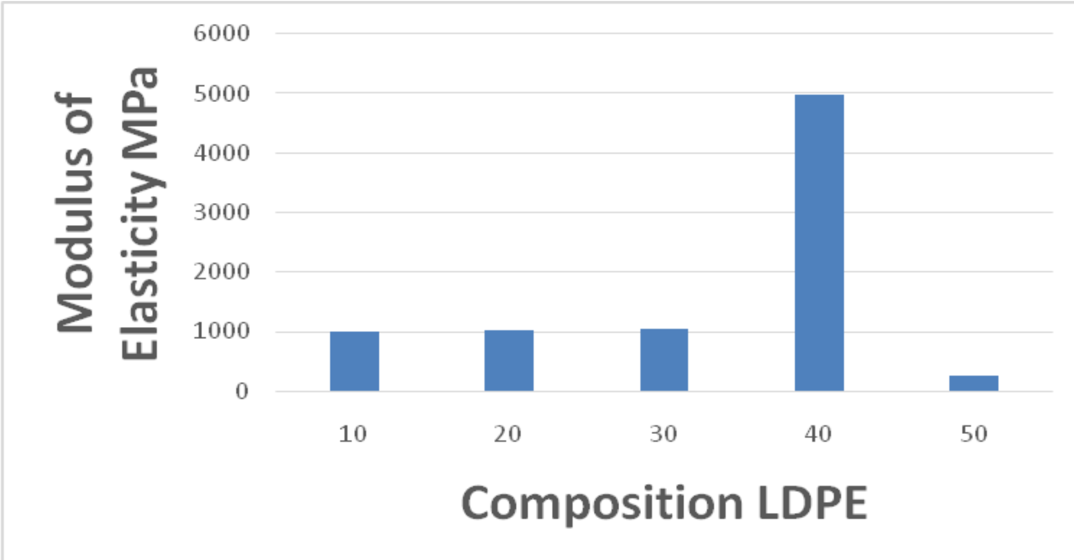


FIG.5: Modulus



The flexural strength, which is the ability of the specimen to resist deformation, is displayed in figure 5. Sample 40% shows higher flexural strength as well as modulus of elasticity (i.e corresponding stress-strain in bending).

CONCLUSION

The results obtained clearly show that polymer blending of LDPE and PVC carried out at different composition influence different mechanical properties of the recycled material. Clearly results have shown that blending of LDPE (10-50) % to PVC, bring about different mechanical properties. The sample composition of LDPE 10% exhibits higher tensile strength and modulus with moderate elongation. There is a linear relationship between the tensile strength and percentage composition of PVC in the samples. Sample 40% has the highest elongation property and modulus of elasticity. The ability of the specimens to resist deformation was best shown by sample 10% having the highest flexural strength and moderate modulus of elasticity (i.e corresponding stress-strain in bending). Therefore blending of the two polymers apart from reducing the production cost of the recycled material can also bring about certain different properties that will lead to different uses.

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APPENDIX

Table A1: Tensile Strength

Composition LDPE/PVC	**Force N**	**Area mm^2**	**Tensile Strength MPa**	**Strain mm^2**	**Elongation %**	**Modulus MPa**
10/90	504	29.64	17.00	0.1	10	170.0
20/80	308	23.5	13.1	0.07	7	18.71
30/70	318	25	12.75	0.06	6	21.2
40/60	280	23.3	12.0	0.19	19	63.2
50/50	220	21.8	10.1	0.08	8	126.25

Table A2: Flexural Strength

Composition LDPE/PVC	**Flexural Strength MPa**	**Modulus of Elasticity MPa**
10/90	46.4	1005.46
20/80	25.94	1029.3
30/70	19.24	1039.0
40/60	21.17	4989.12
50/50	15.00	263.92