Experimental Investigation on the Characteristics of Single Use Waste PET Triturates and Metal Power and its Reinforcement Effects with Epoxy Composites

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***Abstract*— The development of biodegradable plastics has reduced the use of non-biodegradable plastics, but there is no correct answer to the toxic plastics we have used for many years. The main reason for this study is the disposal of disposable PET bottles. Non-biodegradable plastics are discarded rather than reused and eventually land filled. Using grinding techniques to treat waste plastic eliminates the possibility of heat contamination of plastic. Plastic waste is supplied to shredder tools that convert PET bottles into granules or powders. These powders are then mixed with the hardener, metal powder, along with the epoxy and hardener. The mixture can then be immediately poured into the chamber, where the desired product can be obtained in the desired amount. Sample formats are available to meet ASTM requirements and evaluate their mechanical properties (tensile strength, impact strength, bending strength, hardness) and microstructure.**

Index Terms: **hybrid composites; PET bottles; crushing; mechanically.**

1.INTRODUCTION

PET is a semi-crystalline polymer with applications in packaging, building, automotive, household, electrical, and textiles. By mixing PET with the micro to create PET composites from stratified clay, considerable efforts have been made to enhance the various physical, structural, and barriers characteristics of PET. If synthetic polymers are finely ground after grinding, their recovery efficiency increases dramatically.

Polymeric nanocomposites are a class of materials in which nanoscale particulates such as layered clays or spherical inorganic minerals are dispersed within polymeric matrices. Compared to pure polymers, polymeric nanocomposites are claimed to exhibit markedly improved properties, such as modulus, strength, stiffness, flame retardancy, dimensional stability, electrical conductivity, barrier performance, solvent and heat resistance, wettability and dyeability depending on type and content of nanoparticles used.

As load switches must be discovered through "zones" or "regions," reinforcement with the matrix becomes critical. The matrix is large enough that the aggregates don't serve any use other than as a binding agent, i.e., the matrix keeps them in place. The matrix tends to perform the role of load switch to the allocated portion if it isn't progressed as far as the opposite section in the time period of mechanical dwellings. The matrix also works as a barrier to protect against harmful environmental, mechanical, and chemical deterioration, such as abrasion and corrosion. Reinforcement with the matrix assumes importance as load switch needs to be found out through “zones” or “regions”. The matrix is sizeable with inside the feel that the aggregates don’t have any use in any respect except this binding agent, i.e., the matrix holds them in place. The matrix tends to perform the role of load switch to the allocated portion if it isn't progressed as far as the opposite section in the time period of mechanical dwellings. The matrix also serves as a barrier to protect against environmental, mechanical, and chemical deterioration, such as abrasion and corrosion.

2. POLYMER MATRIX COMPOSITE

Polymer matrix composites (PMCs) may be found in nearly every facet of modern life, from electronic

components to a wide range of car accessories. Polymers are frequently made up of carbon - hydrogen branching that are chemically bonded together to form a chain, as their name suggests.
Thermoplastic polymers, thermosetting polymers, and elastomers are all common polymers used in composites. They are a source of a wide range of low-cost raw materials with several benefits, including

1 Low specific weight
2 High material stability against corrosion
3 Good electrical and thermal insulation
4 Ease of shaping and economic mass production
5 Attractive optical properties

Typical plastics used in composites include thermoplastic polymers, thermosetting polymers, and elastomers. They provide a diverse range of low-cost raw materials, as well as several other advantages. Reinforced plastics - confers additional strength and load caring ability by adding embedded metal powder matter into plastics

Advanced Composites - consists of metal powder and matrix combinations that facilitate strength and superior stiffness. They mostly contain high-performance.

3. PROPERTIES OF A PMC

The constituents of a PMC, which affect its overall properties, are:

- Matrix - This is the polymer, which is a continuous phase and is classified as the weak link in a PMC structure.
- Reinforcement - This is a discontinuous phase and is a principal load-bearing component. It can either be glass, quartz, basalt, or carbon fibre.
- Interphase - The interphase between the reinforcement and matrix phases where load transmission takes place.

4. MATERIAL USED

- Single used waste plastic
- Metal Powder

4.1 SINGLE USE WASTE PLASTIC

Single-use plastics are commodities created mostly from fossil fuel–based chemicals (petrochemicals) and intended to be thrown away immediately after use—often in minutes. Containers, wraps, cups, and bags are classic examples of single-use plastics in packaging and service ware. The challenges of throwaway culture are exemplified by single-use plastics.

We frequently value convenience over sturdiness impacts but instead of investment in high things to last. Because of our dependency on plastics, we are producing garbage at an alarming rate. Every year, we generate million tonnes of plastic waste, half of which is used for single-use goods. That's roughly the same as the total human population's weight.

Plastic recycling is the method of gathering waste plastic and reconverting them to new and useful plastic products. The world produces and makes use of more than a trillion pounds of plastic material. Plastic recycling ensures that this massive amount of plastic does not go to waste. Instead, you can reprocess the materials to get other products.

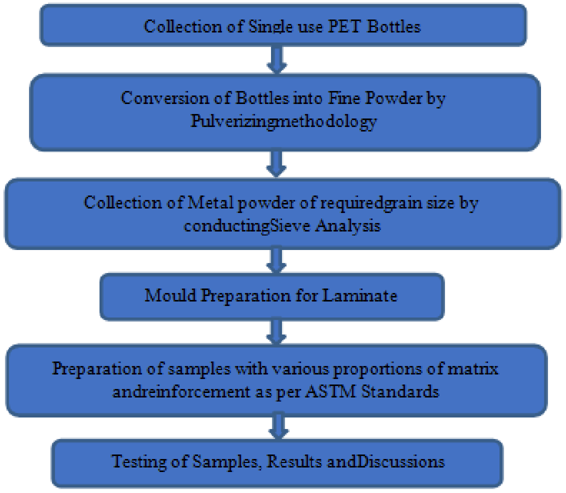
4.2 METAL POWDER

The particle size distribution, particle shape, surface condition, and structure of powder particles are all factors to consider. These influence bulk qualities including reactivity, flow ability, compressibility, porosity, and hardenability, which all improve as particle size decreases.

Powder flow, powder packing, porosity, reactivity, and even safety and health are mostly influenced with particle size and form in most metal powder operations. Whether spraying, spreading, pressing, or sintering, these qualities must always be tuned for the specific end process. Metal powders with a high density and an uniform loading pattern are linked to the creation of components with fewer faults and consistent quality.

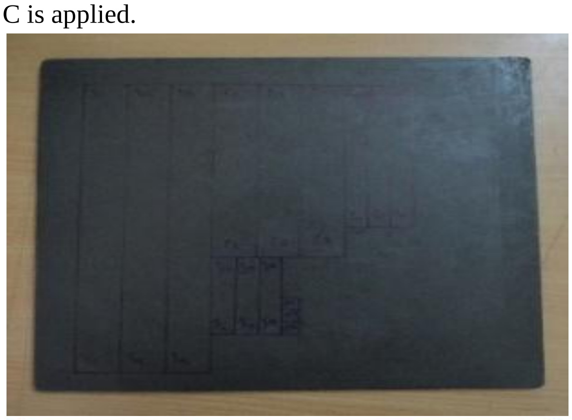
Metal powder for additive manufacturing (3D printing, Rapid prototyping) is available in a wide range of particle size distributions that are tailored to the individual additive manufacturing systems.

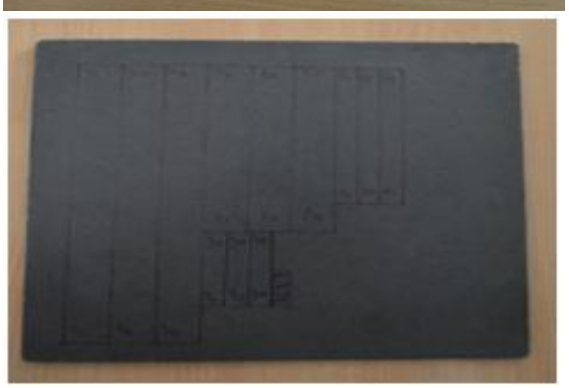
5. METHODOLOGY



6. COMPRESSION MOULDING

Compression moulding is a faily simple procedure concerning quick or squeezing a deformable cloth price among halves of a heated mold and its next transformation right into a moulded component after curing in a certain time. Herestress approximately 1500psi and temperature approximately 900 to 1000 C is applied.





Mould plate

tensile testing is the most commonly used for obtaining the mechanical characteristics of isotropic materials. Some materials use biaxial tensile testing. The main difference between these testing machines being how load is applied on the materials.

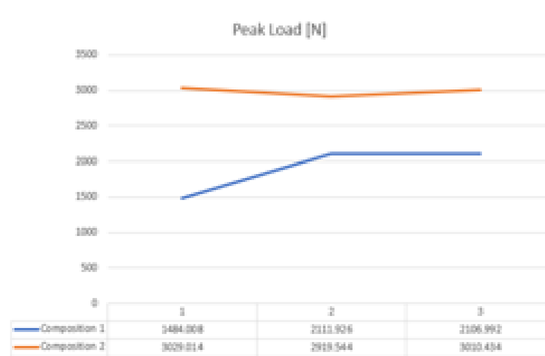
7.1 TEST

7.1.1Tensile Test for Polymer Matrix Composite

Tensile testing, also known as tension testing, is a fundamental materials science and engineering test in which a sample is subjected to a controlled tension until failure. Properties that are directly measured via a tensile test are ultimate tensile strength, breaking strength, maximum elongation and reduction in area. From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics. Uniaxial

SAMPLE No.	CS AREA [MM2]	PEAK LOAD[N]	%ELONGATION	UTS[N/MM2]
1	150	1484.008	2.290	9.888
2	150	2111.926	2.550	14.077
3	150	2106.992	2.560	14.048
4	150	3029.014	3.120	20.189
5	150	2919.544	3.030	19.463
6	150	3010.434	2.000	20.071

Composition 1



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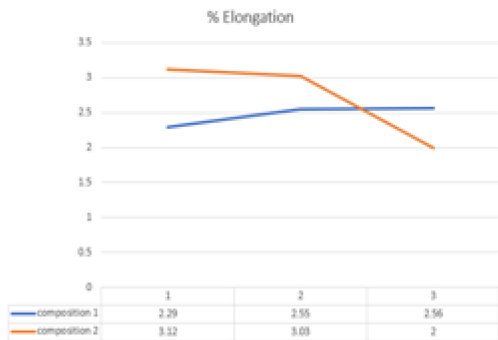


7.1.2 COMPRESSION TEST

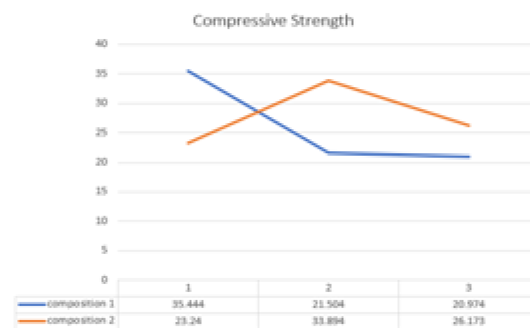
Compression testing is a very common testing method that is used to establish the compressive force or crush resistance of a material and the ability of the material to recover after a specified compressive force is applied and even held over a defined period of time. Compression tests are used to determine the material behaviour under a load. The maximum stress a material can sustain over a period under a load (constant or progressive) is determined.

Compression testing is often done to a break (rupture) or to a limit. When the test is performed to a break, break detection can be defined depending on the type of material being tested. When the test is performed to a limit, either a load limit or deflection limit is used.

SAMPLE NO.	CS AREA [MM2]	PEAK LOAD[N]	COMPRESSIVE STRENGTH[N/MM2]
1	150	5316.000	35.444
2	150	3225.930	21.504
3	150	3145.586	20.974
4	150	3485.415	23.240
5	150	5084.376	33.894
6	150	3926.237	26.173

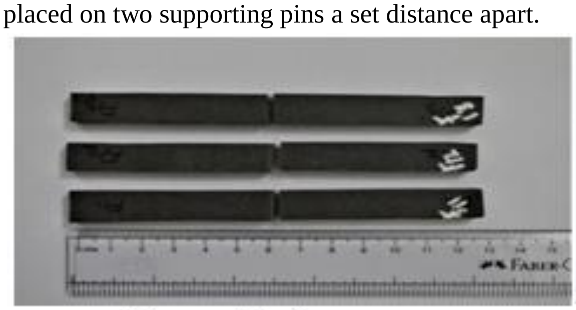
Composition 1

Composition 2

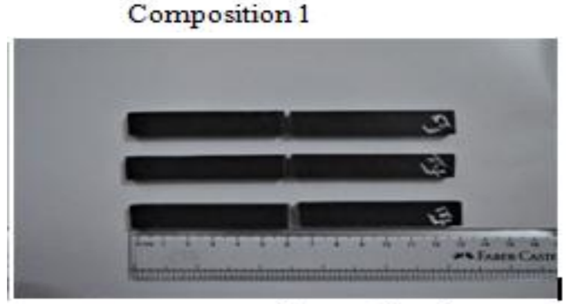


7.1.3 FLEXURAL TEST

The test method for conducting the test usually involves a specified test fixture on a universal testing machine. Details of the test preparation, conditioning, and conduct affect the test results. The sample is placed on two supporting pins a set distance apart.

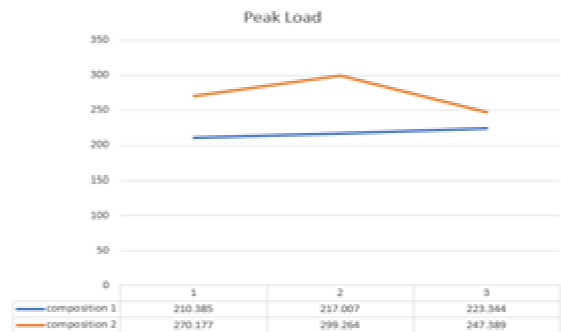


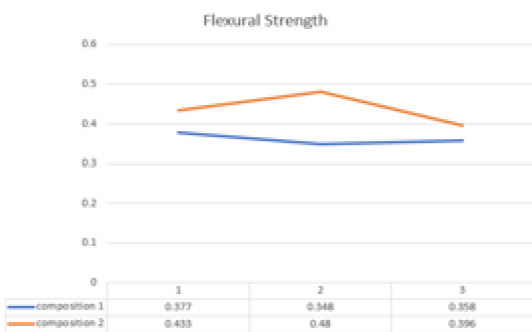
Composition 1



Composition 2

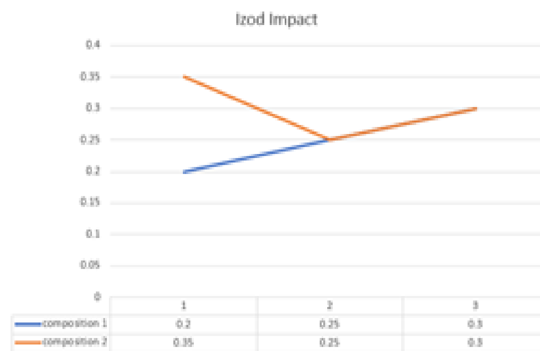
Sample No.	CS Area [mm2]	Peak Load [N]	Flexural Strength (MPa)	Flexural Modulus (GPa)
1	150	210.385	0.337	2.763
2	150	217.007	0.348	2.437
3	150	223.344	0.358	2.920
4	150	270.177	0.433	3.020
5	150	299.264	0.480	2.879
6	150	247.389	0.396	2.610





Composition 2

S. No	Izod Impact value in J for 6mm thickness
1	0.20
2	0.25
3	0.30
4	0.35
5	0.25
6	0.30



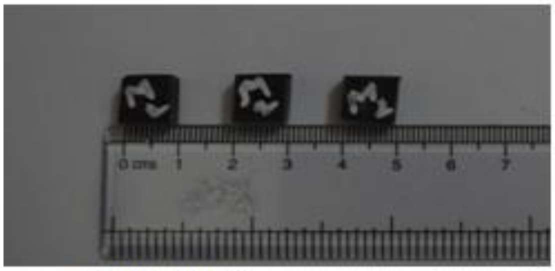
7.1.4 IMPACT TEST

The Izod impact strength test is an ASTM standard method of determining the impact resistance of materials. A pivoting arm is raised to a specific height (constant potential energy) and then released. The arm swings down hitting a notched sample, breaking the specimen. The energy absorbed by the sample is calculated from the height the arm swings to after hitting the sample. A notched sample is generally used to determine impact energy and notch sensitivity.

Composition 1

7.1.5 MICRO-HARDNESS TEST

The Vickers hardness test was developed in 1921 by Robert L. Smith and George E. Sand land at Vickers Ltd as an alternative to the Brinell method to measure the hardness of materials.[1] The Vickers test is often easier to use than other hardness tests since the required calculations are independent of the size of the indenter, and the indenter can be used for all materials irrespective of hardness. The basic principle, as with all common measures of hardness, is to observe a material's ability to resist plastic deformation from a standard source. The unit of hardness given by the test is known as the Vickers Pyramid Number (HV) or Diamond Pyramid Hardness (DPH). The hardness number can be converted into units of pascals, but should not be confused with pressure, which uses the same units. The hardness number is determined by the load over the surface area of the indentation and not the area normal to the force, and is therefore not pressure.



Composition 1

Composition 2

S. NO	MICRO HARDNESS (VICKERS) HV (H)	AVERAGE HV (H)
1	28.96	29.40
2	30.38	
3	28.87	
4	27.46	29.03
5	29.66	
6	29.97	
7	32.82	30.43
8	27.02	
9	31.46	
10	33.79	29.85
11	28.48	
12	27.29	
13	29.36	26.22
14	25.19	
15	24.11	
16	37.36	36.76
17	36.25	
18	36.66	

8. CONCLUSION

The polymer matrix composite was reinforced with Metal powder and single-use waste plastic. We utilised waste plastics in powdered form by employing a plastic pulverising machine, so there will no need of heating or melting the plastic and there is no possibility of toxic gases escaping into the atmosphere that causes air pollution and this is achieved by pulverization technique that converts plastic flakes into powder or granules. which does not pollute the environment. As a result, it aids in the reuse of plastics while also reducing pollution. We created two kind of compositions here. In comparison to the first type composition, the second type composition has produced a better result. Since these plastics are mixed with resin it becomes corrosion resistant and heat resistant and provides a prolonged life to the product. The use of metal powder adds strength and stiffness to the composite. Since metal are used as a dispersed phase of reinforcement, it results in producing light weight components without sacrificing the strength.