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STUDDING THE IMPACT EFFECT OF POLYSTYRENE – CADMIUM-TELLURIUM HYBRID

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Abstract
In this study a synthetic composite of polystyrene and cadmium and tellurium was fabricated with certain percentages(4%,8%,12%) to impact test by manual molding method under (230-240) temperature the experimental results showed of the impact gradual increase in weight fraction of cadmium and decrees in tellurium.

Introduction

In last years , new types of plastics have developed to be a great challenge for the scientific and technological society because of the effect of plastics on the environment and the overstock of polymers materials[1] this time, great challenge to improve the mechanical, thermal, and electric conductivity properties of thermoplastic polymers by using particles filler]2,3]. high impact and gradually expanded purposes. In ancient times , The composite materials consist of two or more materials while are differ in physical and mechanical properties to get a new material with good properties]4,5]. Polystyrene was discovered in 1839 by Edward Simon [6].Polystyrene was produced at first time in Germany (1930). Today it is one of the most widely manufactured polymers in the world in second place after polyethylene. The main reason for this we can set it up by heating collection of useful products because it is clear and transparent. It allows to add different colors to the plastic in its liquid state .One of the main uses of polystyrene is the manufacture of polystyrene foam for pack stuff for shipping it is also used to make disposable cutlery ,dishes and cups. It can also manufacture medical and pharmaceutical equipment. [7]

In (2018), Rafid Hamad Khalaf studied the properties of impact, bending, tension, Hardness Compression, dialectical constant and thermal Conductivity for micro and Nano(ZnO) with polymer blends. He found that the impact, bending, tension decreased with increasing the concentration of (ZnO), but Hardness Compression, dialectical constant and thermal Conductivity increased with increasing sand concentration for all grain sizes[8].
In (2018), Shihab A. Zaidan studied the Iraqi kaolin with different percentages of Expanded Polystyrene (EPS) waste crumbs additions were investigated. After mixing and forming by hand molding, the specimens was dried and fired at (1300℃) .The structural, physical, mechanical and thermal properties of the refractory insulating products were measured. Maximum addition of EPS (1.25 wt%) led to reduce the linear shrinkage to less than (1.7% wt%) and increased apparent porosity up to (50 %) [9].

In (2019), Ghasaq Talal Suhail studied the influence of (SiC) , (CdO) and (clay) nano and particles on some physical properties for epoxy polyurethane blends. She concluded that the mechanical tests of Impact strength (I.S) showed that all samples in natural conditions and (UV) irradiation decreased by increasing the weight fraction, samples more than that of particulate samples for the same weight fraction in the both cases [10].

Aim of The Study:

The present study aims at:

- Preparing composites materials from polystyrene resin reinforced by (CdxTe1-x)
- Studying the effect of weight fraction of reinforced materials of (CdxTe1-x/PS) on impact strength

Hybrid Composites :

Hybrid is a word from (Greek-Latin origin). And Hybridization is a process of incorporating single reinforcements such as (fillers , fibers, flakes particles). In polymer blends or the incorporation of two reinforcements in one polymeric matrix phase the purpose of this process is to get new material different from the original materials that enter in composition with perfect mechanical properties, such as tensile , compressive and impact strength, stiffness, thermal stability and least water absorption properties) be in [11].

Hybrid composites are composites that are made from two or more types of different materials which may be Ceramic or Metals or organic or inorganic materials with weak van der Waals interaction or hydrogen bonding or electrostatic interaction, this represents the first type. But the second type due to the strong chemical interaction (covalent bonds) . These fillers with different structures and different geometric shapes dispersed in polymeric by physically or chemically ways with macro or Nano scale level [12].

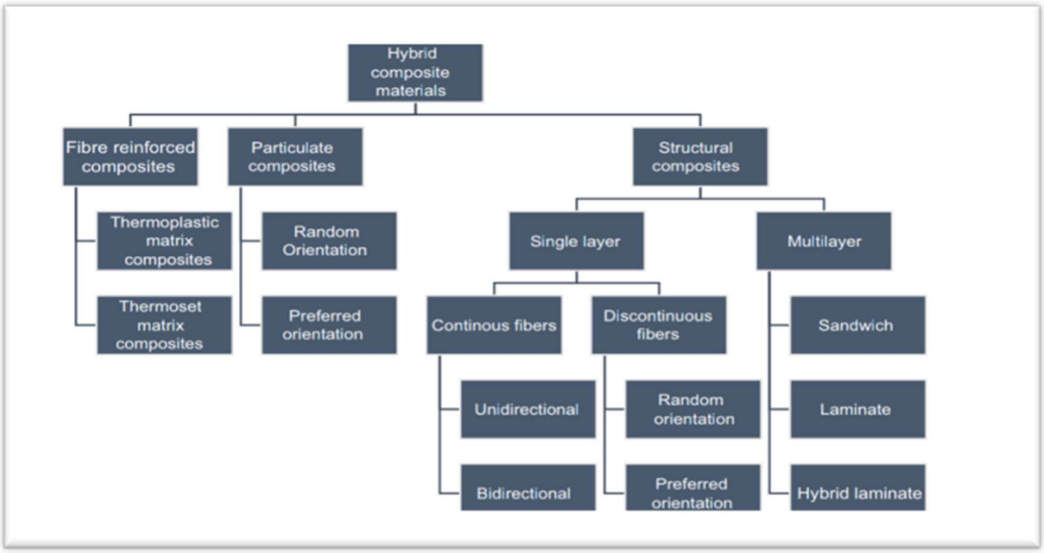
Classification of Hybrid Composites

Hybrid composites can be classified into:

- Interplay called (two by two) which two or more from reinforced materials combine regular or random arrangement
- Sandwich or called (Core –Shell) which can describe one material as a Sandwich between two layers [13].
- Interplay called also Laminated consists of two layers or more from materials alternate accumulate in regular style
- Intimately mixing very close that has random orientation to avoid center concentration from one material to another [14].
- Other types like Sticks ,wires ,Ribs, thin rails or combination from above

In this figure(1), three reinforced (Zn,Te,Cd) with polystyrene matrix are used.

Figure (1) The classification of hybrid composites



Advantages of Hybrid Composites :

The most advantages of these hybrid are :

- It keeps the cost by replaced expensive materials with cheap materials
- We can get unique new materials with perfect physical and mechanical properties by good choice of reinforced materials.
- Various applications of these composites enter in many felids because they have light weight ,strength ,so they are used in airplane structure making and various medical applications [15].

Aims of Testing Materials

Some of the reasons for testing materials are :

- To check the imperfections within the structure of the specimen, e.g. (cracks, cavities or inclusions). Such methods of examination may be part of a company's quality – control program.
- To specify the mechanical properties of strength, hardness, toughness and ductility of the material. The results from such tests enable the designer to provide the most suitable shape and section capable of withstanding the expected stress levels.
- To evaluate the performance of the material in specific operating conditions. Such tests may be described as fatigue, which involve alternating stresses. Creep tests are the applied load which remains constant [16].

Types of Loading

Mechanical properties of materials are related with the material performance when subjected under effective loading. Loading which affects materials that can be classified into three major types [16]:

- Static loading: - The effect of load here is slow and it increases gradually till reaching its maximum value without any impact or vibration like tension test. Continuous loading or remaining of effective load for a long time is always considered as static loading.
- Dynamic loading: - Load effect on material with occurrence of impact or vibration. An example of this type of loading is collision of moving body with another (like an aero plane

landing on airport's ground).

- Periodic loading: - M p is indirect [8]

Impact Strength:

Impact strength (I.S) is one of the important mechanical properties of material testing .It is used to measure the energy absorbed by the samples. There are two main types of this test called :[17].

- Charpy test is used to test metallic materials and it has two notch points (U&V).Notches and the sample take horizontal position with notch point facing away from the pendulum and the dimension of samples (55×10×10mm).
- Izod test is used to test plastic and metals which have one notch point (Vnotch) only, and the sample takes vertical position and the notch is facing towards the pendulum and the dimension (75×10×10mm) of sample. Figure (2) illustrate this difference.

The load applied from the weight of pendulum or hammer that raises to certain height from fixed point(h). The sample is in place then the hammer descends from the height and strikes sample and break. It calculates the difference between (h) and (h') and measures the angle through the pendulum falls and angle when pendulum rises. We can compute absorbed energy. Then we measure impact strength from following relationships: [18]

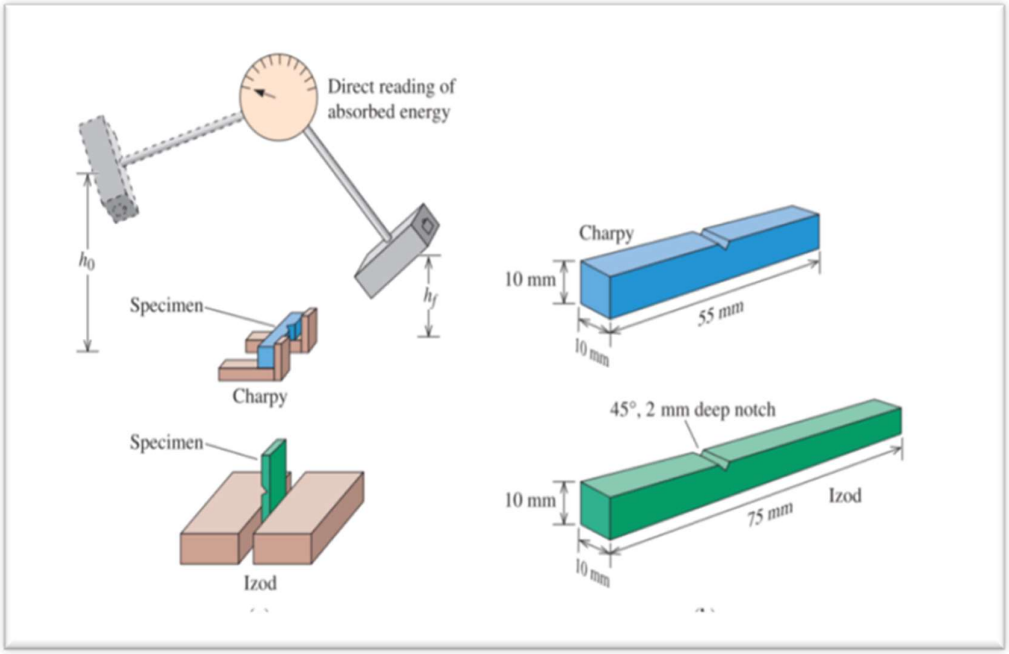


Figure (2): The Impact pendulum, Charpy and Izod test

Neglecting losses, the energy used in breaking away the specimen determined is given below:

Let:

W = Weight of the pendulum,

α = Angle through which the pendulum falls,

β = Angle through which the pendulum rises,

R_p = Distance between the center of gravity of the pendulum and the axis of rotation.

The initial energy of the pendulum should be

$= WR_p (1 - \text{Cos } \alpha)$ ……..….(1)

and energy after breaking the specimen

$= WR_p (1 - \text{Cos } \beta)$ …….…….…....(2)

Energy required to break away the specimen

$= WR_p (1 - \text{Cos } \alpha) – WRp (1 - \text{Cos } \beta)$ ……..…..……. (3)

$= WRp (\text{Cos } \beta - \text{Cos } \alpha)$ .....……..…….. (4)

Impact strength is calculated from the relation.

I.S =U/A (KJ/m2)……..……..……...(5)

Where:

I.S = impact strength

U = Energy of fracture in (KJ)

A = Cross section in (m2)[2].

For (Cd_xTe_{1-x})/ PS:

Concerning the second group **G_2** and as shown in table **(1)** and figure **(3),** the impact strength value is at the first ratio **Ψ_1** and the first sample of **G_2**, the same at the ratio **Ψ_1** and the first sample from **G_1 (0.68KJ/m^2)**. Because the mixing ratio here is equal, only polystyrene and tellurium is **(Cd0%).** Polystyrene is fixed at **(96%).** So we get the same result .While at the sixth sample, it became **(1.5KJ/m^2)** .That is ,it increased gradually with an increase (x) for cadmium and decrease in tellurium but it is less valuable than the value of the sixth sample from the first group **G_1** .This is because cadmium possesses less durability than zinc and it is higher than tellurium**[11].**

Table (1) Impact strength. For (CdxTe1-x) /PS

Group Number	Weight Fraction	Sample Number	Sample Composition	Impact Strength (KJ/ m^2)
G_2	Ψ_1=0.04	1	Cd(0%)Te (4%) + 96% PS	0.68
		2	Cd(0.8%)Te(3.2%)+96%PS	0.72
		3	Cd(1.6%)Te(2.4%)+96%PS	0.8
		4	Cd(2.4%)Te(1.6%)+96%PS	0.97
		5	Cd(3.2%)Te(0.8%)+96%PS	1.21
		6	Cd(4%)Te(0%)+96% PS	1.5

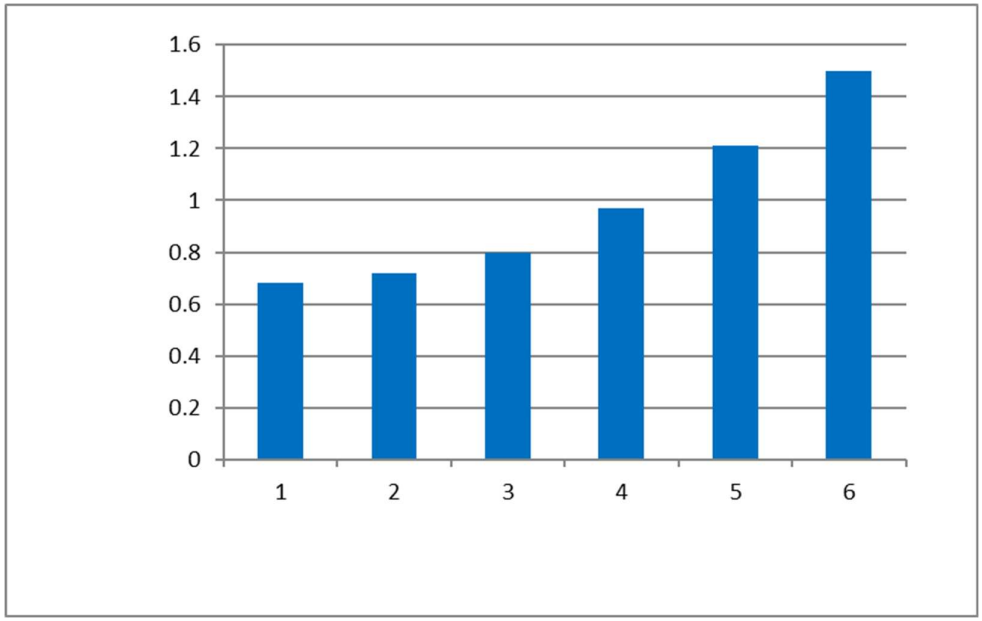


Figure (3) Impact Strength of (CdxTe1-x) /PS with Sample Number.

According to table **(2)** and the figure **(4)**, the impact strength increased slightly. From the readings of the first group, impact strength was **(1KJ/m^2)** at the first sample it became **(1.92KJ/m^2)** at the sixth sample. It increases with (x) of cadmium increases and increases with weight fracture ratio increase because the grain size of cadmium is less than the grain size of tellurium where cadmium has **(60µm)** while tellurium has **(76µm)**. This makes it fill the spaces between the polystyrene molecules, thus the bonds between them increase because these particles will make barrier to the developing crack through the composites materials which cause the crack to change in shape and direction leading to secondary cracks which lead to increase the surface area of fracture **[11]**.

Table (2) Impact Strength of (Cd_xTe_{1-x}) /PS

Group Number	Weight Fraction	Sample Number	Sample Composition	Impact Strength (KJ/ m^2)
G_2	Ψ_2=0.08	1	Cd(0%)Te(8%)+92%PS	1
		2	Cd(1.6%)Te(6.4%)+92%PS	0.99
		3	Cd (3.2%)Te(4.8)+92%PS	1.14
		4	Cd(4.8%)Te(3.2%)+92%PS	1.27
		5	Cd(6.4%)Te(1.6%)+92%PS	1.6
		6	Cd(8%)Te(0%)+92%PS	1.92

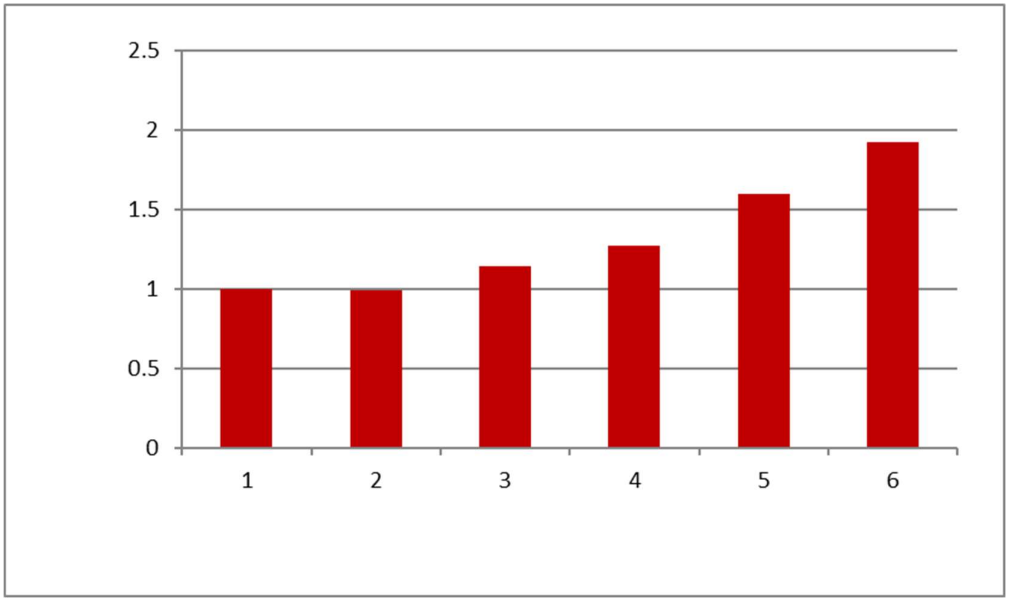


Figure (4) Impact Strength of (CdxTe1-x) /PS with Sample Number.

As shown in table **(3)** and figure **(5),** the impact strength also increased with an increase in the percentage of weight fracture and with an increase (x) of cadmium and decrease in tellurium where it increases from **(1.33 to 2.1) KJ/m^2** because the grain size of cadmium is less than the grain size of tellurium where cadmium has **(60µm)** while tellurium has **(76µm)**. This makes it fill the spaces between the polystyrene molecules, Thus the bonds between them increase because these particles will make barrier to the developing crack through the composites materials which cause the crack to change in shape and direction ,leading to secondary cracks which lead to increase the surface area of fracture.

Table (3) Impact strength of (Cd_xTe_{1-x}) /PS

Group Number	Weight Fraction	Sample Number	Sample Composition	Impact Strength (KJ/ m^2)
G_2	Ψ_3=0.12	1	Cd(0%)Te(12%)+88%PS	1.33
		2	Cd(2.4%)Te(9.6%)+88%PS	1.4
		3	Cd(4.8%)Te(7.2%)+88%PS	1.573
		4	Cd(7.2%)Te(4.8%)+88%PS	1.69
		5	Cd(9.6%)Te(2.4%)+88%PS	1.97
		6	Cd(12%)Te(0%)+88%PS	2.1

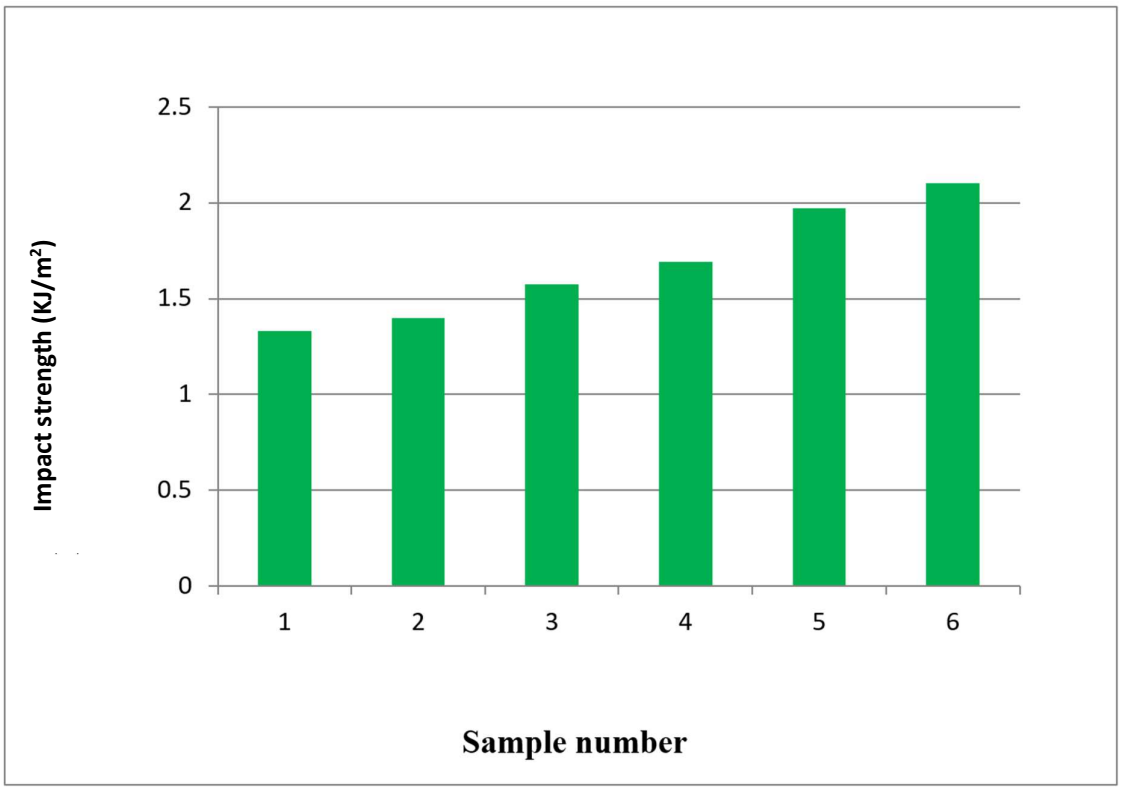


Figure (5) Impact Strength of (Cd_xTe_{1-x}) /PS with Sample Number.

Figure **(6)** gives a comparison of three ratios **(Ψ_1,Ψ_2,Ψ_3)** which show that the best impact strength value was at the third ratio **Ψ_3** and the sixth sample where recorded **(2.1KJ/m^2).** But the impact values for the second group is lower than the impact values for the first group because the physical properties of zinc are better than the physical properties of cadmium and the grain size of zinc is less than the grain size of cadmium that causes zinc particles to penetrate between polymers molecules to strengthen it more than cadmium. Thus, the bonds between them increase because these particles will makes barrier to the developing crack through the composites materials which cause the crack to change in shape and direction ,leading to secondary cracks which lead to increase the surface area of fracture. The ratio of polystyrene decreased to **(88%)** at the ratio **(12%)** from weight fraction where the lower the percentage of polystyrene and the greater the percentage of mineral additives ,the better impact strength we get. Therefore the best readings were at the third group and the third ratio means that the impact strength increases linearly with the ratios of addition to the reinforced materials.

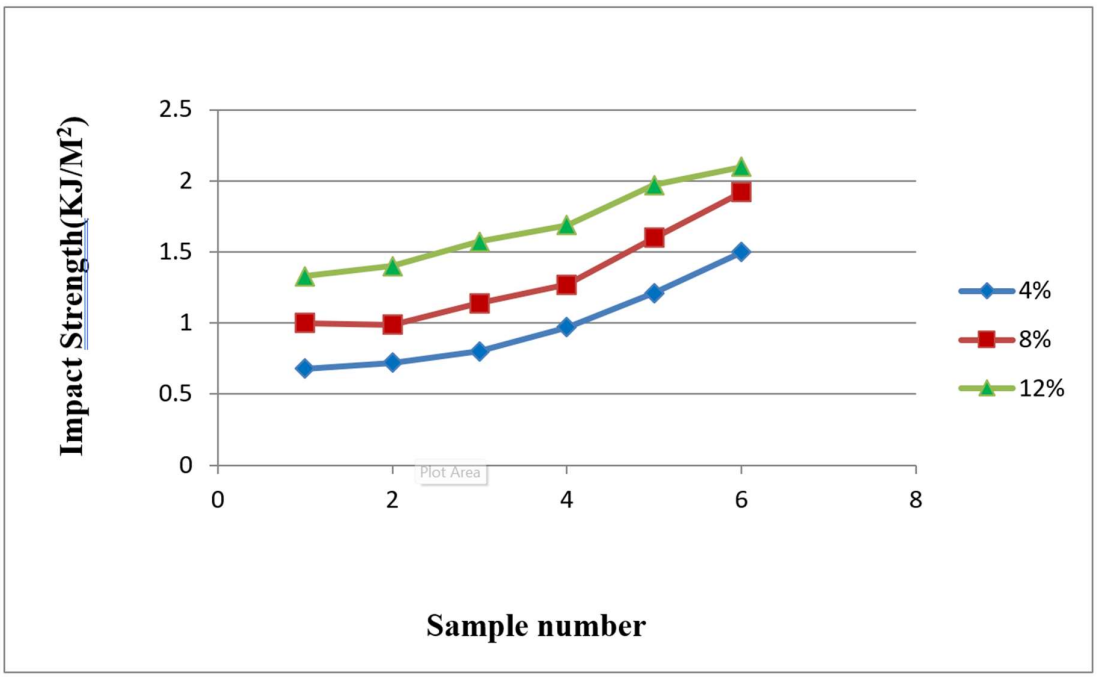


Figure (6) Impact strength test for weight fraction of

Conclusions

This work has come up with important conclusion :

the Impact Strength for (Cd_xTe_{1-x}/PS) gradually increases with wt% increasing for all percentages

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