STRENGTH ANALYSIS OF POLY-URETHANE

Shishupal Singh[1], Nishant Singh[2], Shreyash Chaudhary[3]

[1]*Assistant professor, Department of Mechanical Engineering, Invertis University, Bareilly (India)*
[2]*Assistant professor, Department of Mechanical Engineering, Invertis University, Bareilly (India)*
[3]*Department of Mechanical Engineering, Invertis University, Bareilly (India)*

ABSTRACT

A nylon fabric coated urethane was developed. Poly-urethane materials are considered to be cheap in comparison to other materials with higher strength and properties. As this family of materials is a part of the emerging world of engineering materials, as it has low weight with higher strength, it is fire proof and water proof which makes it more useable for the industries for different purposes. Therefore, in the following research, some tests has been conducted to analyze the strength of the nylon fabric coated urethane. The analyses of strength was done on the basis of Energy Dispersive X-ray Analysis (EDAX), Differential Scanning Calorimetry (DSC) and Universal Testing Machine (UTM).

Keywords- ***DSC, Glass Transition Temperature, Isocyanates EDAX, Poly-Urethane, PU Resin.***

I. INTRODUCTION

Polyurethanes are any type of polymer containing a urethane linkage. The urethane linkage is -NH-CO-O-.[2] The way to form polyurethanes is done by reacting iso-cyanates with compounds that have an active hydrogen, such as diols, that contain hydroxyl-groups, in the presence of a catalyst. Since there are many compounds containing active hydrogens and many different di-isocyanates, the number of polyurethanes that can be synthesized is also large. The specific properties of the polyurethane can be tailored to a specific need by combining the appropriate compounds. Polyurethanes can exist as both rigid and flexible foams, and as a coating or adhesive material. Since polyurethanes come in so many forms and can have a wide variety of properties, it is also used in many different applications. Rigid polyurethanes are used as insulation and flotation, while flexible ones are used for cushioning and packaging.[1] In addition, they are used as adhesives in construction and transportation. Polyurethanes are mostly thermosets, which means they are hard to melt and reprocess and can therefore have the disadvantage of being non-recyclable. Differential Scanning Calorimetry (DSC) is used to find out the different phases of a material at different temperatures when it is heated for a particular time period.[4] Basically the temperatures of three phases for any material are most important which includes starting temperature of material, glass transition temperature or transition phase[6] and melting temperature. Energy Dispersive X-ray Analysis Test (EDAX) is used for X-ray analysis of polyurethane material. This test helps to find out the individual element percentage present in the material. Universal Testing

Machine (UTM) is used for calculating the strength of material under tensile or compressive load. We have calculated the strength of polyurethane material.

II. MATERIAL SPECIFICATION

As per the analysis and by some measurement using vernier caliper of polyurethane we find out thickness of coated fabric of the material that is used in making different product. And measured data are mentioned below:

Gram per square meter (GSM) of coated fabric = 1380 gm/cm^2.

Thickness of coating on both sides = 0.125mm

Total thickness of coated fabric = 0.5mm

The fabric material is polyester.

The polyurethane coating is used.

Fig. 1: Polyurethane specimen

III. TESTING

3.1 Energy Dispersive X-Ray Analysis Test

It is one of the variants of X-ray fluorescence spectroscopy which relies on the investigation of a sample (polyurethane) through interactions between electromagnetic radiations.[3] We take two sample of polyurethane for experiment and then X-rays emitted by the matter in response to being hit with charged particles. Computer identifies the element on the basis of unique atomic structure so X-rays that are characteristic of an element's atomic structure to be identified uniquely from one another. After that computer map the graph for each element. It is seen that in each sample mostly percentage of Carbon, Nitrogen and Oxygen element are found. In polyurethane material these Carbon, Nitrogen and Oxygen are present so it is verified.[7]

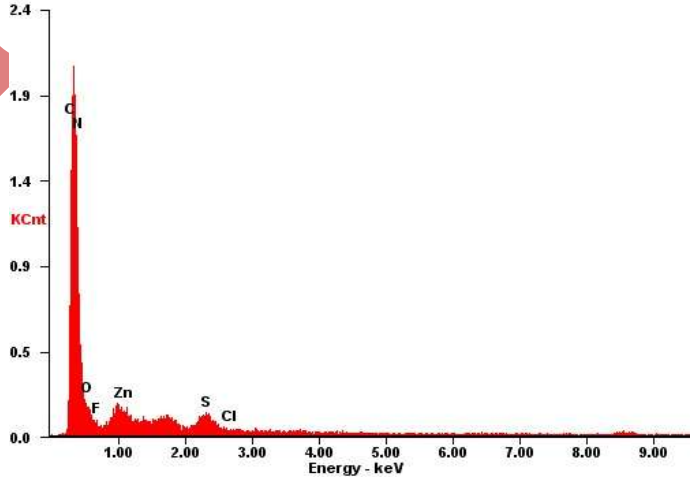

Fig. 2: EDAX Graph

TABLE 1 Elemental data of EDAX Graph

Elements	Weight%	Atom%
CK	26.68	30.28
NK	66.91	65.10
OK	04.37	03.73
FK	00.69	00.49
ZnL	00.78	00.16
SK	00.56	00.24

As per the graph for sample it is seen that the peak value of Carbon, Nitrogen are plot by the system and other element is arranged in a tabular form which is shown in the table. So it is clear that atomic weight percentage of carbon and nitrogen is high.

3.2 Differential Scanning Calorimetry Test

Differential Scanning Calorimetry (DSC) is the most-employed thermal analysis method. DSC is used widely for examining polymeric materials to determine their thermal transitions phase and some other properties like melting point, glass transition temperature, percent crystallinity and heat of melting.[8]

As per the graph on the basis of DSC test it is seen that transition of Polyurethane fabric takes place at the temperature of 60.14^{0}C. And temperature 111.74^{0}C is known as glass transition temperature of Nylon fibre. At 250.91^{0}C Nylon fibre goes melt down thus it can be said that it is the melting point of Nylon fibre.[9]

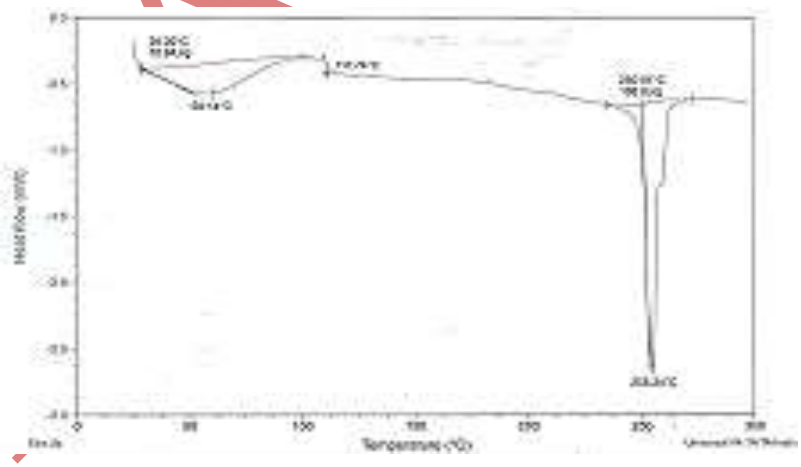

Fig. 3: DSC graph

3.3 Strength Test

This test shows the strength of the material. We prepare the specimen for this test with dimensioning of 7× 2.5 cm^2 size and then attached to the universal testing machine. When power is on, it will give the breaking load of material and it come near about 220N. This is good enough. Tensile test perform after the samples are taken out from oven. These samples are tested for strength on Universal Testing Machine. During tensile test.it is found that all samples plot the almost same graph. So it is clear the strength is near about 900 to 1000 kg/cm^2.

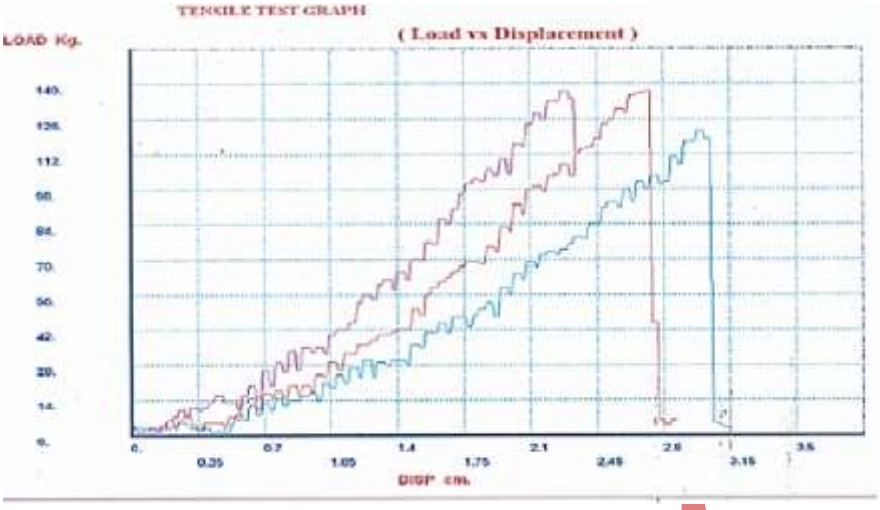

Fig. 4: Tensile test graph

TABLE 2 Test result of specimen

S.No.	Max. Disp. (cm)	Strength(Kg/Sq.cm)	Speed	Load Cell (kg)
1	75.25	989.000	500	3000
2	68.25	1096.000	500	3000
3	57.50	1096.000	500	3000

IV. REPAIR SCHEME

To develop the repair scheme firstly prepare the adhesive. And it is mixture of two part (base + hardener) which is especially designed for polyurethane coated fabric. Take a particular ratio of hardener (Iscocyanate adduct) and PU resin.[5] The hardener and resin are mixed in the ratio of 10: 100 ml.

ISCOCYANATE ADDUCT (10 ml) + PU RESIN (100ml) = POLYURETHAN ADHESIVE

The repair scheme is developed for reinforcing the weekend joint using polyurethane adhesive and the coating material is polyurethane in nature so compatibility is assured. It was found that no material degradation has taken place due to ageing as compare to their present strength value.

Fig. 5: Specimen after repair scheme

TABLE 3 Stress comparison of specimen

Fabric specimen	Breaking Load
Specimen after repair scheme	2400 N
Specimen before repair scheme	2096 N

When performed the tensile test on joint fabric then it is found that breaking load for specimen before repair work is 2096N and after repair work in 2400N. During this tensile test UTM speed is taken as 400 mm/min.

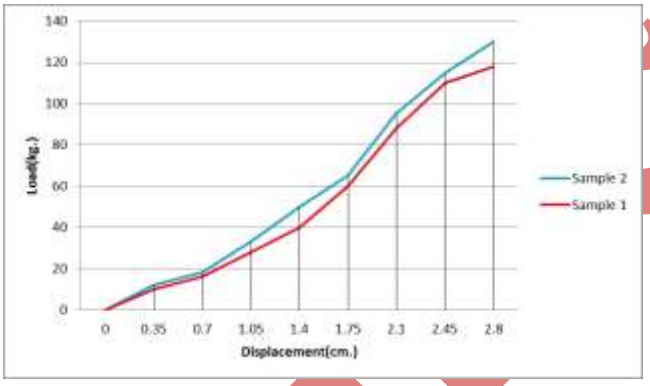

Fig. 6: UTM Graph

V. CONCLUSION

On the basis of the tests and results of the above research we came to the following conclusions:

(a) As per the EDAX test it was found that the percentage of carbon and nitrogen was high and as we know that carbon increases the strength of any composite material, therefore the strength of the sample is high.

(b) According to the results of the DSC test the melting point of the sample was high, i.e., 250.91^{0}C, which clearly indicates that the composite can withstand high temperature and the elements would not detach to this value.

(c) The UTM test also showed good results, as on 400mm/min the breaking load before work is 2096N and after repair work in 2400N.This shows that the strength of the sample is very high and can withstand considerably high amount of stresses.

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Biographical Notes

Mr. Shishupal Singh Working As An Assistant Professor In Mechanical Engineering Department, Invertis University, Bareilly (U.P.).

Mr. Nishant Singh Is Working As An Assistant Professor In Mechanical Engineering Department, Invertis University, Bareilly (U.P.).

Shreyash Chaudhary Is Pursuing B.Tech.-M.Tech. Dual Degree Course In Mechanical Engineering Department At Invertis University, Bareilly (U.P.).