THERMALLY CONDUCTIVE AND ELECTRICAL INSULATION OF EVA SHEET

Paritosh Kumar Sharma[1], Prof.Rupande N Desai[2], Prof.Gnanu Bhatt[3]

[1] Student, Rubber Technology LD College of Engineering, Ahmedabad, Gujarat, India
[2] Prof, Rubber Technology LD College of Engineering, Ahmedabad, Gujarat, India
[3]Prof, Rubber Technology LD College of Engineering, Ahmedabad, Gujarat, India

ABSTRACT

Ethylene vinyl acetate (EVA) encapsulation materials have attracted a lot of attention due to their extensive applications in solar cells. Nearly 80% of photovoltaic (PV) modules are encapsulated by EVA materials. EVA has lots of advantages, such as good light transmittance and elasticity, low processing temperature, excellent melt fluidity, and adhesive property. In addition, the price is low, which makes it very suitable as a solar cell encapsulation material. However, there are also some problems with EVA. This article pays special attention to improving the performance of EVA encapsulation films. In addition, it differentiates between different properties also the static charge develop due to heating of glass attached to the upper surface creates problems and due to long use of Eva sheet in solar panel encapsulation the dust which gets deposited on the surface of sheet and the gap between the glass and sheet also reduces the effectiveness of solar cells in converting the radiation of sun into the electrical energy or electricity.

Keyword: - *EVA, Encapsulant, photovoltaic module*

1. INTRODUCTION

Now days due to high demand of energy in various sectors such as industries, homes etc. leading to more consumption of more resources based on fossil fuels. But these non renewable sources of energy will deplete soon so the invention was carried out for renewable energy resources such as use of solar panel, wind mill, dams, etc. so form among these listed energy resources the best selected was solar panel. Because the installation cost, maintenance cost is very low also the durability is very high so many us adopted the concept of solar panel as the source of energy.

1.1 Introduction to EVA

The first ethylene copolymer with the EVA was come into the existence in 1930s. This was developed by ICI in Great Britain. The chemical structure to produce EVA is shown below in figure 1.

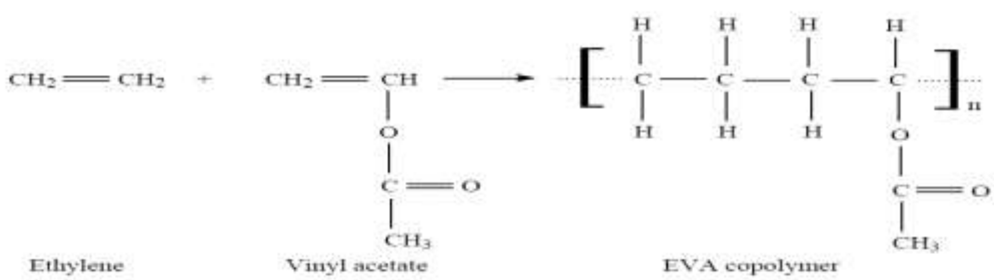

Fig -1: Manufacture of EVA

Ethylene-vinyl acetate (EVA), also known as poly (ethylene-vinyl acetate) (PEVA), is the copolymer of ethylene and vinyl acetate. The weight percent vinyl acetate usually varies from 10 to 40%, with the remainder being ethylene.

Broadly speaking, there are three different types of EVA copolymer, which differ in the vinyl acetate (VA) content and the way the materials are used.

The EVA copolymer which is based on a low proportion of VA (approximately up to 4%) may be referred to as vinyl acetate modified polyethylene. It is a copolymer and is processed as a thermoplastics material – just like low density polyethylene. It has some of the properties of a low density polyethylene but increased gloss (useful for film), softness and flexibility. The material is generally considered as non-toxic.

The EVA copolymer which is based on a medium proportion of VA (approximately 4 to 30%) is referred to as thermoplastic ethylene-vinyl acetate copolymer and is a thermoplastic Elastomer material. It is not vulcanized but has some of the properties of a rubber or of plasticized polyvinyl chloride particularly at the higher end of the range. Both filled and unfilled EVA materials have good low temperature properties and are tough. The materials with approximately 11% VA are used as hot melt adhesives.

The EVA copolymer which is based on a high proportion of VA (greater than 40%) is referred to as ethylene-vinyl acetate rubber.

2. Study and Experiment

The paper "Thermally conductive and electrically insulating EVA composite encapsulants for solar photovoltaic (PV) cell" showed that Thermal conductivities of the composites filled with SiC, ZnO or BN reach respectively 2.85, 2.26 and 2.08 W/m•K at filler content of 60 vol%.

The composites filled with ZnO or BN exhibit superior electrical insulation to those filled with SiC or Al2O3. ZnO can promote the cross-linking reaction of the EVA matrix. The test results indicated that the EVA composite encapsulating rear films filled with thermal conductive fillers are able to improve the PV efficiency and the heat dissipating ability of the solar cell effectively.

The electrical insulation is a very important property of the encapsulant of a solar cell. The electrical insulation here is termed as ANTISTATIC which referred to as the restriction of development of static charge in the EVA sheet in the solar module.

Based on the studies above I choose the following materials for my practical work to be carried out. The following materials are listed as:

- Magnesium oxide
- Zinc oxide
- Aluminium oxide
- Dicumyl peroxide
- Silane coupling agent- 3 glidoxy propyltrimethoxy silane
- TAC
- EVA (18% & 28% VA)

From the point of the functioning of the materials the base material i.e. EVA, I choose two grade for the comparison and test for the development of static charge in the two grades.

The second material which is Di-cumyl Peroxide (DCP) is used as the curing agent as EVA here is grade having vinyl acetate content of 18% and 28%, so, the grades are thermoplastic in nature and to cure a thermoplastic material it is recommended to use peroxide curing agent.

The other additives such as Magnesium Oxide, Zinc Oxide and Aluminium Oxide are used to investigate the electrical insulation properties. These materials are from merk industries having excellent properties at laboratory scale.

Additionally silane coupling agent which is an important role in the EVA sheet i.e. it keeps the sheet transparent as it is necessity to keep the film transparent then and then only we get the best results. The coupling agent is from NANJING LANYA CHEMICALS CO LTD.

2.1 Experiment

In the trail I used extruder for better mixing of all ingredients. For that firstly I have to correctly weight all the ingredients which are mentioned in the formulation below.

In the mean time of correct weight of all the ingredients according to the formulation the extruder is to be set with correct processing temperature of EVA with all other processing condition such as pressure, output rate etc.

From the formulation used above the below mentioned process is to be followed.

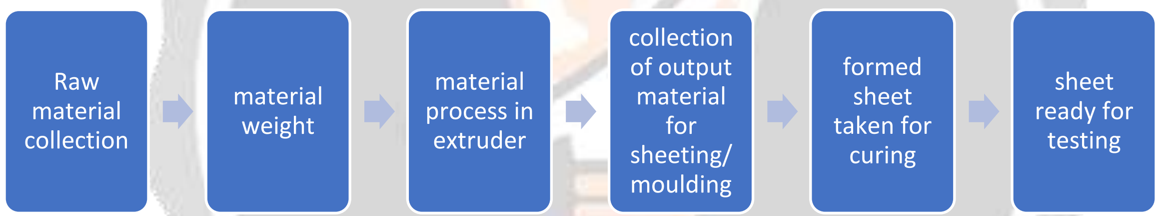

Fig -2: Processing of EVA with all ingredients

3. TESTING PROCEDURE

The testing procedure plays a very important role in the determination of desired property to be achieved by the specimen after the modifications. So to get the desired property some of the tests are as follows:

- Electrical Insulation Test
- Gel Content Test
- UV Test

3.1 Electrical Insulation Test

To determine the electrical insulation of EVA modified sheet the test procedure is ASTMD 257. This test is also known as surface resistivity test or volume resistivity test. In this test the resistivity measurement is above $10^7 \Omega$per square.

Fig -3: Equipments used to measure electrical insulation

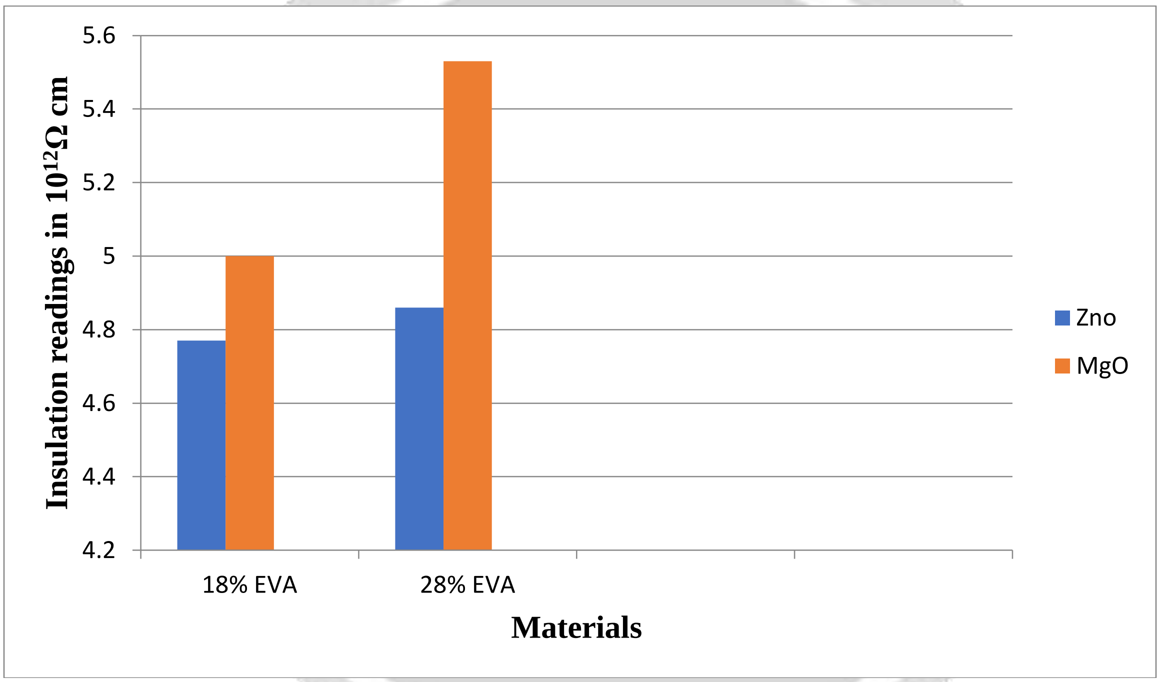

Table -1: Comparison of insulation property of EVA 28% and EVA 18% filled with Zno

3.2 Gel Content Test

The gel content test is very important test. This test is used to carry out the amount of rubber part in the sample. The method used is known as ASTM D 2765.

GEL CONTENT TEST	
MATERIALS	**RESULT**
18% EVA MODIFIEED WITH MgO	79%
18% EVA MODIFIEED WITH ZnO	76.5%
28% EVA MODIFIEED WITH MgO	81.5%
28% EVA MODIFIEED WITH ZnO	84%

Table -2: Results of gel content

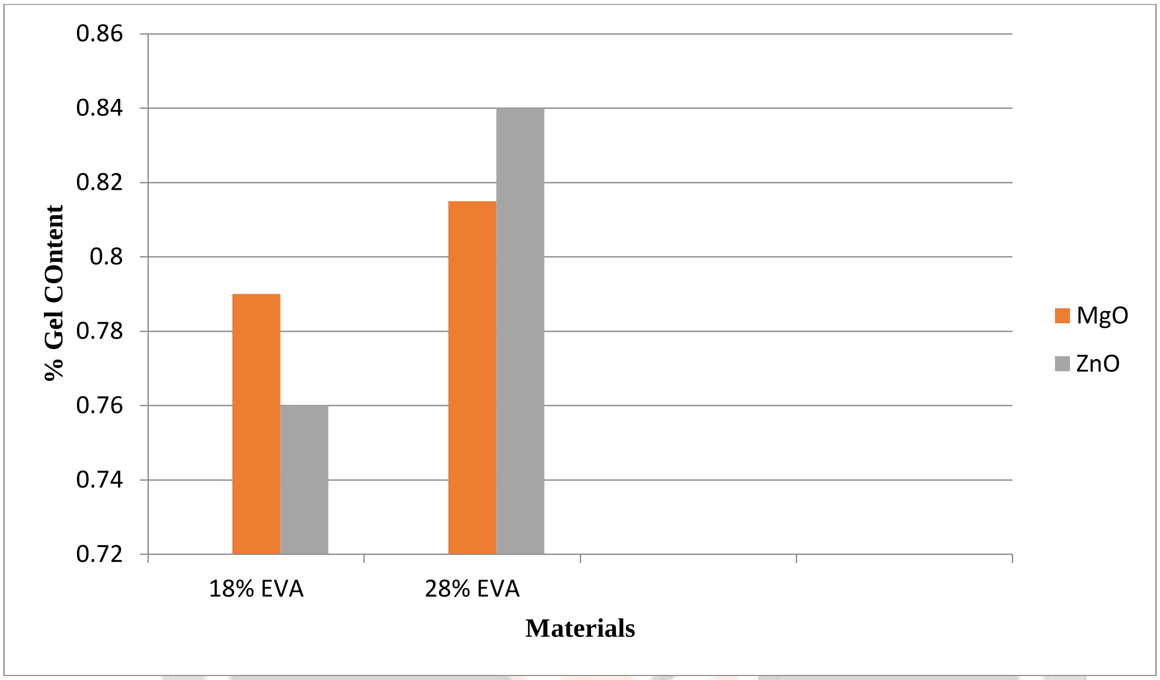

Table -3: Comparison of Gel Content of EVA 28% and EVA 18% filled with Al_2O_3, MgO and Zno

3.3 UV Test

As per many studies shown that Eva sheet is not compatible to UV radiation which results in the yellowing of EVA sheet and also lacks in the efficiency of solar module. In this testing i was able to carry out some of the results but before going further let us understand the process of testing which is listed below

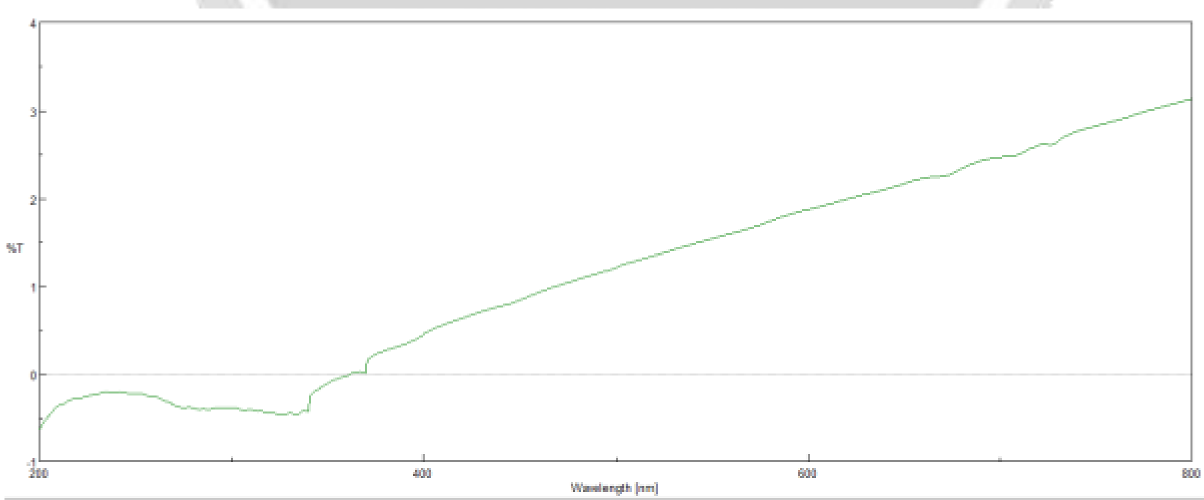

Fig -4: RESULTS OF 18% EVA MODIFIED WITH AL_20_3

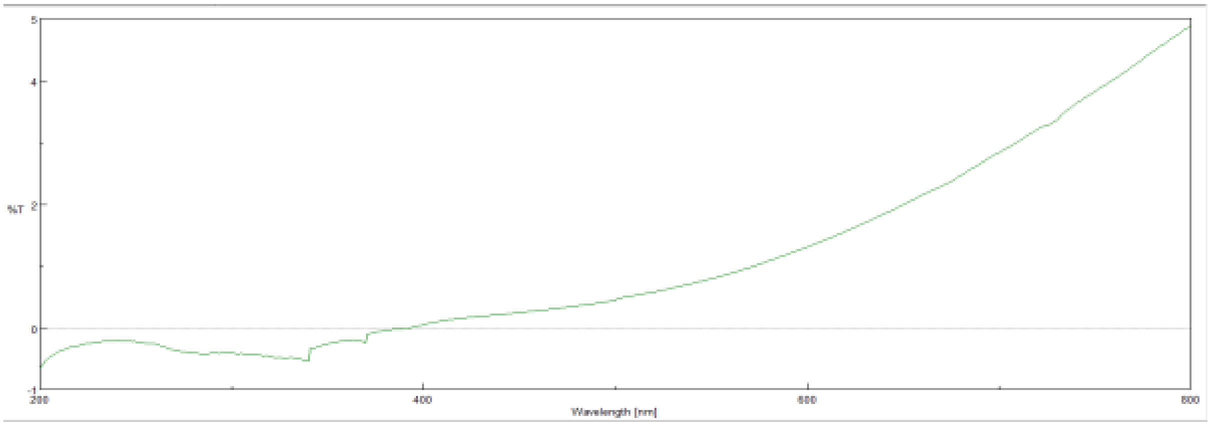

Fig -5: RESULTS OF 18% EVA MODIFIED WITH MgO

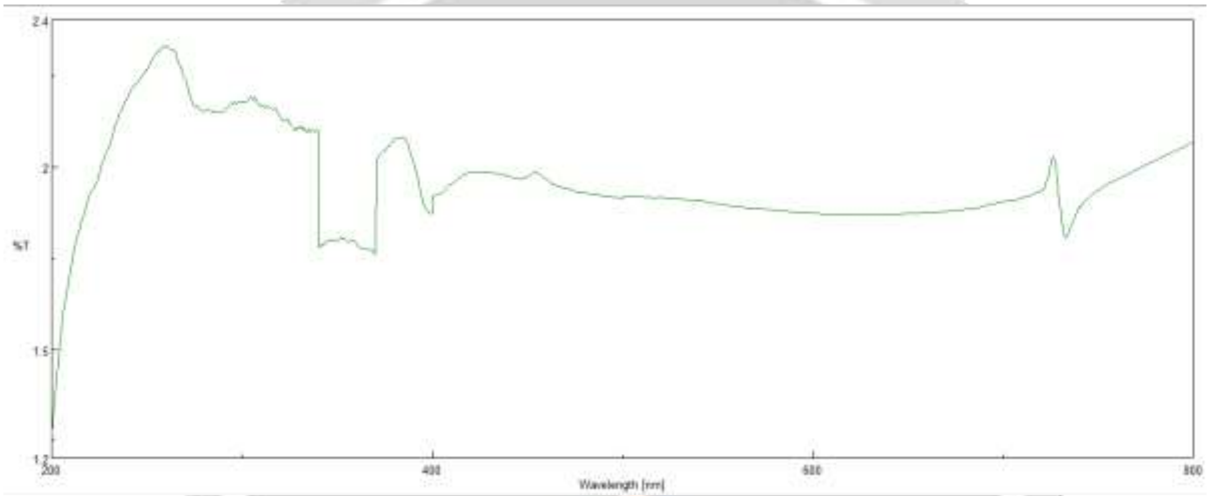

Fig -6: RESULTS OF 18% EVA MODIFIED WITH ZnO

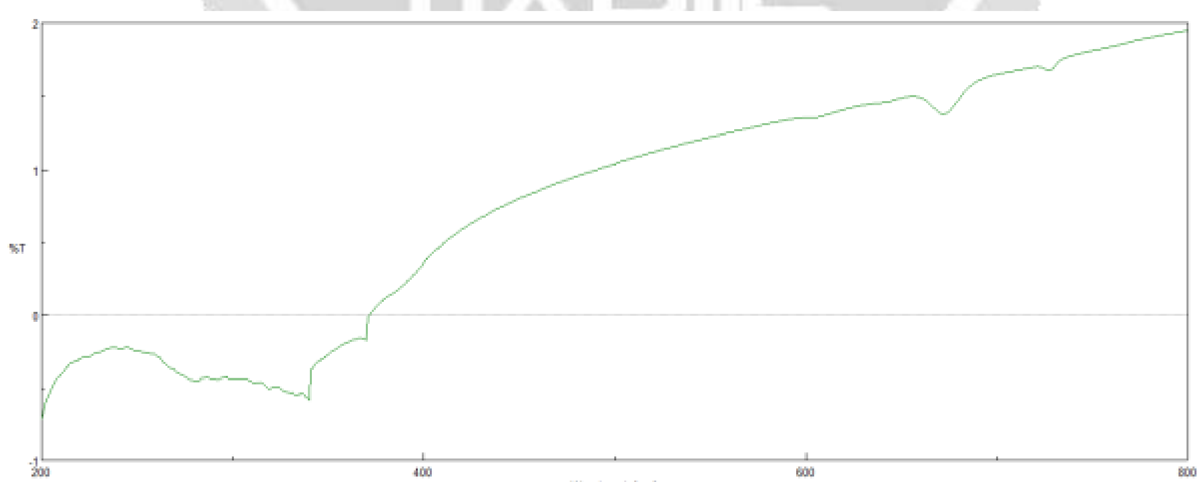

Fig -7: RESULTS OF 28% EVA MODIFIED WITH AL_20_3

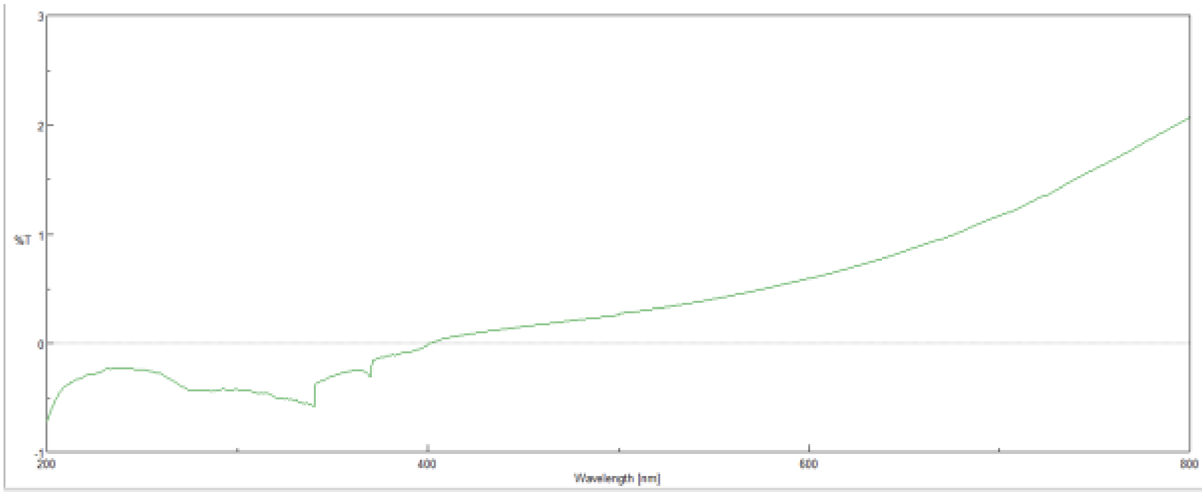

Fig -8: RESULTS OF 28% EVA MODIFIED WITH MgO

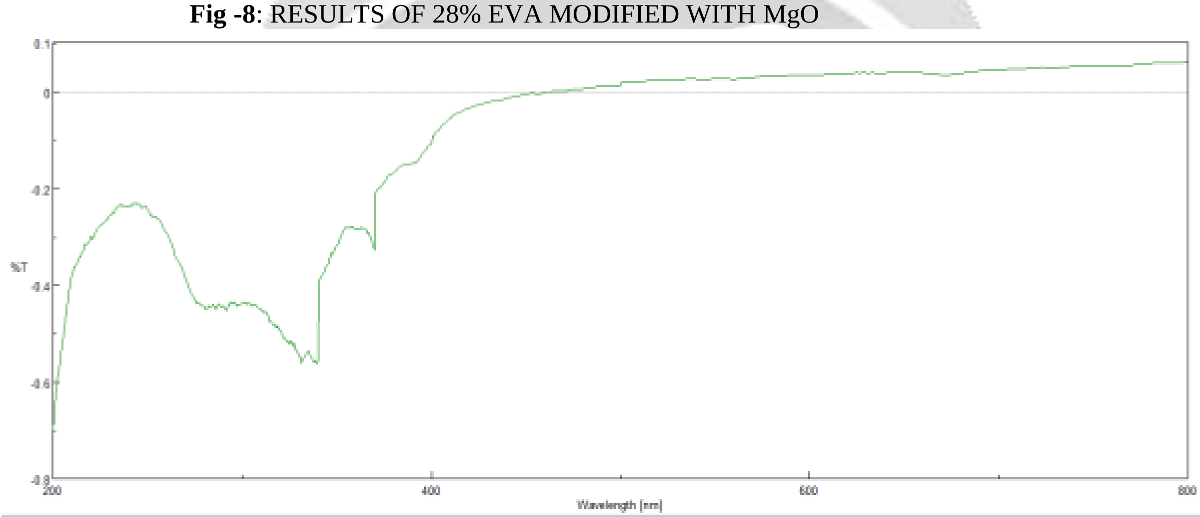

Fig -9: RESULTS OF 28% EVA MODIFIED WITH ZnO

3.4 Thermal Conductivity Test

This test is also very useful as the title stated that thermal conductive and electrical insulation of EVA sheet. In this test micrometer is used to test the values.Below are the results of the test.

THERMAL CONDUCTIVITY TEST	
MATERIALS	**RESULT**
18% EVA MODIFIEED WITH MgO	0.115 W/m*K
18% EVA MODIFIEED WITH ZnO	0.086 W/m*K
28% EVA MODIFIEED WITH MgO	0.104 W/m*K
28% EVA MODIFIEED WITH ZnO	0.003 W/m*K

Table -4: Results of thermal conductivity of EVA

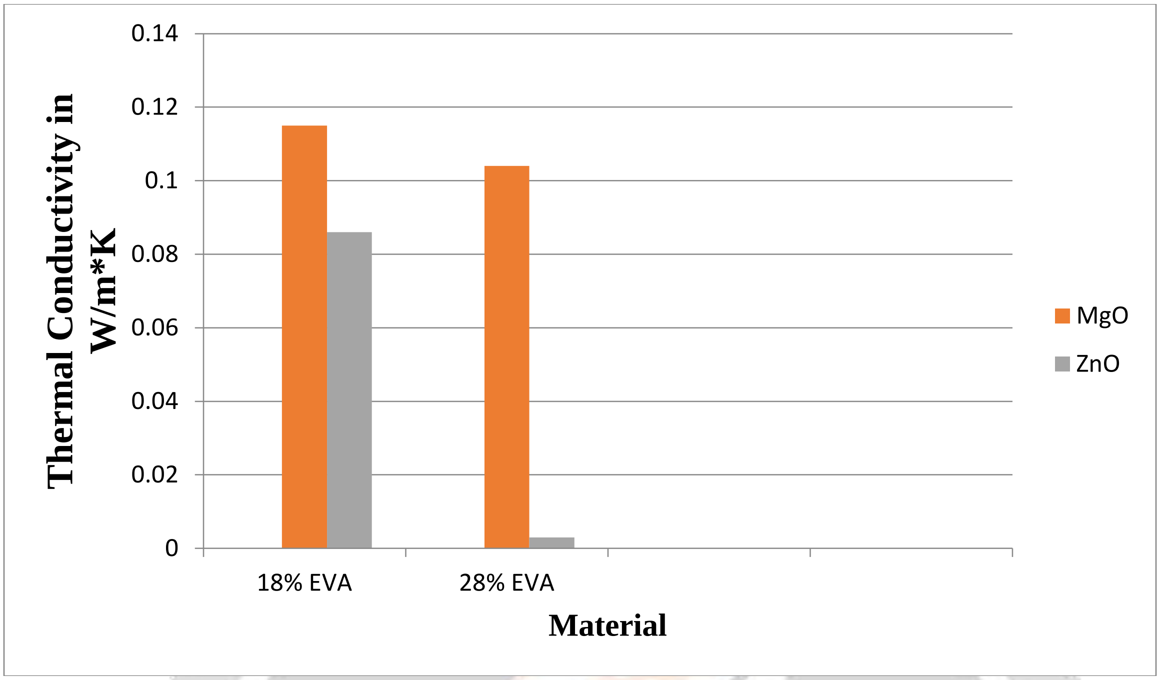

Table -5: Comparison of Thermal Conductivity of EVA 28% and EVA 18% filled with Al_2O_3, MgO and Zno

4. CONCLUSIONS

From more literature survey and testing I was able to develop the EVA sheet as per the property mentioned in the title. Also from the results I got from different testing required to achieve the property are satisfactory upon my knowledge.

Based on the comparison between two grades of EVA I will like to introduce 28% EVA modified with Al_2O_3 as the values are very near to the market values.

Also in the comparison of 18% EVA modified with Zno and 28% EVA modified with Zno the 28% EVA modified with Zno shows more electrical insulation, so we can use 28% ZnO for better electrical insulation.

Finally in the uv test due to thickness of the EVA sample sheet was high so due to that the transmission of light is very less which resulted in lower values but if we reduce the thickness of EVA sample sheet upto 0.4 mm the transmission will be higher and the values of the higher.

5. REFERENCES

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