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# Tensile Properties of PMMA/SAN Blends at Different Temperatures

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***Abstract*—The thin films of poly (methyl methacrylate) (PMMA), poly (styrene-co-acrylonitrile) (SAN) and their blends were prepared by means of melt mixing method at different temperatures. The prepared blends are transparent. The miscibility is observed in these blends since the AN content of SAN was between approximately 9% and 33% by weight. Mechanical properties such as tensile strengths were determined. Some increase in tensile strength obtained for 80/20 blends. It is found out that strength of the blend is various with respect to melt mixing temperature and blend ratio.***

***Index Terms*— PMMA, SAN, Melt mixing method.**

## I. INTRODUCTION

Polymer blends have an important role in a specific polymer industry sectors. The currently available polymers and their blends are not sufficient for meet the required performance requirements. Polymer blending is a convenient route to develop new materials with specific properties that are superior to those of the constituent polymers. The blending of polymers is an easy and inexpensive method of modifying various properties of a polymer such as process ability, tensile strength, and impact strength. Polymeric materials are rarely used in their pure state. Blending different polymers has been identified as the most versatile and economic method to satisfy the complex demands for performance, such as adhesion, optical and fracture toughness. [1]

Blends of poly (methyl methacrylate) (PMMA) and poly (styrene co- acrylonitrile) (SAN) are miscible when the acrylonitrile (AN) content in SAN copolymer ranges between 9 and 33 wt %. [2] The mixture of PMMA and SAN forms a miscible blend and the origin of miscibility of PMMA/ SAN blends has been suggested to be the repulsion effect between styrene and acrylonitrile units in SAN and also intermolecular interaction. [3] Smaller the phase domain size indicates the miscibility of the system. [4] PMMA/SAN blends show the lower critical solution temperature (LCST) behavior. The cloud point for 50/50 blend is reported to be around 180˚C, which is below the usual melt processing temperature of PMMA or SAN. The PMMA/SAN forms a miscible blend at room temperature. [5]

## II. EXPERIMENTAL

### *A. Materials*

Polymers used in this study were Polymethyl Methacrylate (PMMA) specific gravity 1.2 g/cm3 and water absorption (24h)-0.30% (melt index: 5.8) obtained from plaskolite west inc, and Styrene Acrylonitrile (SAN) (AN content: 29 wt %, mass flow rate: 5g/10min, water absorption : 0.14%) obtained from LG Chem ltd .

### *B. Preparation of PMMA/SAN Blends*

PMMA and SAN were dried for 4h at 80° C before blending. After drying PMMA and SAN are taken in various proportions for Blending. Blend is prepared by melt mixing in a Thermo scientific Haake. It consists of two roller type rotors. The mixing chamber has a volumetric capacity of 69m³. Sample weight of for each mixing is 40g. This machine is provided with different operation conditions by varying Mixing temperature of polymer blend, mixing duration (Time), Rotation speed of rotor (RPM). PMMA and SAN were put through the cooper at the same time and melt mixed in Thermo Haake to prepare polymer blend at processing temperatures varying from 180 to 220°C.

Blending of thermoplastic materials by melt mixing process is carried out by the application of temperature. The temperature of melt mixing is carried out above the melting temperature of individual polymer. Usually the mixing process is carried out above the glass transition temperature in thermoplastics. The temperature of mixing is very important which controls the viscosity and shearing energy of polymers. Higher amount of heat causes thermal degradation of material. Mixing time is an important factor in deciding uniform dispersion of filler material throughout the blend. In sufficient time causes improper mixing of polymers.

After the preparation of blend, test samples are prepared using Moulding process. Compression Moulding process is used for the preparation of test samples. Electric Thermo hydraulic press is used for compression Moulding. It

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consist of two movable plates moves upwards and downwards. Die of 130x130 mm of dimensions are used for the preparation of tensile samples, which makes blend in the form of thin film.

### *C. Characterization and measurements*

Ultimate tensile strength (UTS) is the maximum stress that a material can withstand while being stretched or pulled before failing or breaking. Some materials will break sharply, without deforming, called a brittle failure and others are more ductile, including most metals will stretch some and for rods or bars, shrink or neck at the point of maximum stress as that area is stretched out. The most common testing machine used in tensile testing is the universal testing machine. This type of machine has two crossheads, one is adjusted for the length of the specimen and the other is driven to apply tension to the test specimen. Universal testing machine (50 KN) is used for measuring tensile strength of the test specimen based on ASTM D882. Rectangular specimens of 100 x 10 mm were used for determining the tensile strength. The tests were performed on six different specimens of the same sample and the average was taken as the final value.

## III. RESULT AND DISCUSSION

The tensile result of PMMA/SAN blend was found out and the graphs are plotted.

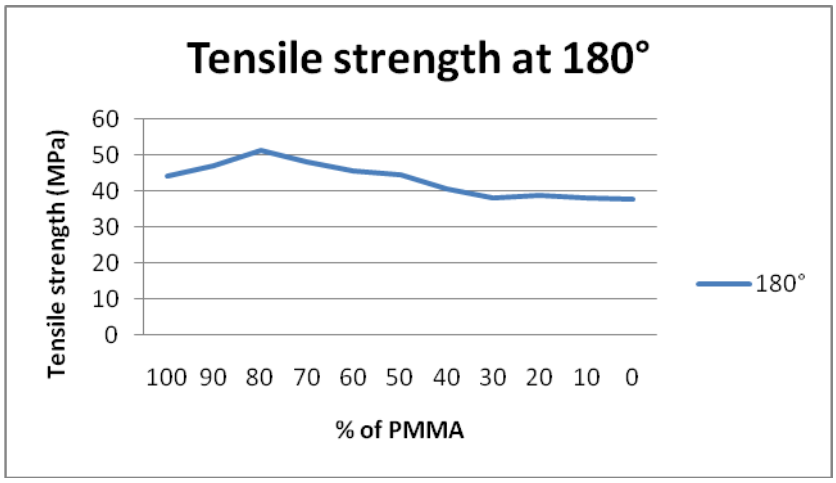


**Fig 1: Tensile strength of PMMA/SAN Blend at 180°C**

The tensile strength of PMMA/SAN blend increases with increase in SAN content up to 20%.after that the result showing a decreasing trend. The maximum tensile strength obtained is 51.4 MPa and the lower tensile strength for pure SAN. The strength decreases steeply from 80/20 blend to 30/70 blend after that the strengths of each blend is almost identical.

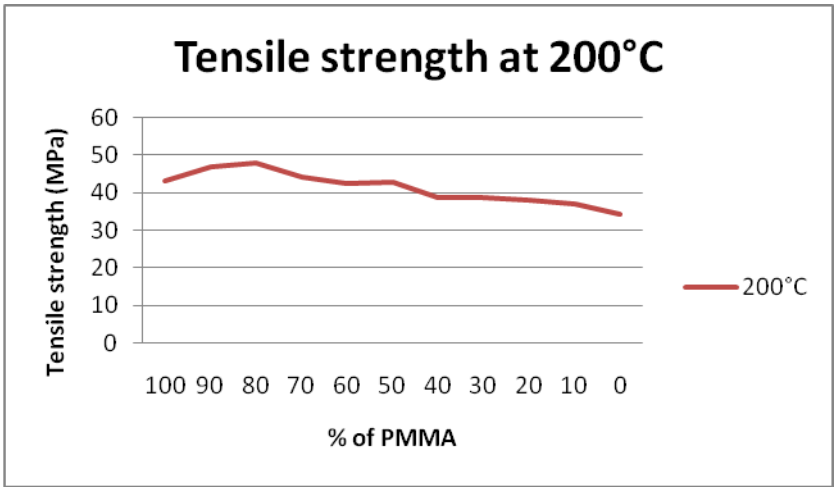


**Fig 2: Tensile strength of PMMA/SAN Blend at 200°C**

The tensile strength of PMMA/SAN blend increases with increase in SAN content up to 20%.after that the result showing a decreasing trend. The maximum tensile strength obtained is 47.98 MPa and the lower tensile strength

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for pure SAN. The strength decreases steeply from 80/20 blend to 0/100 blend.

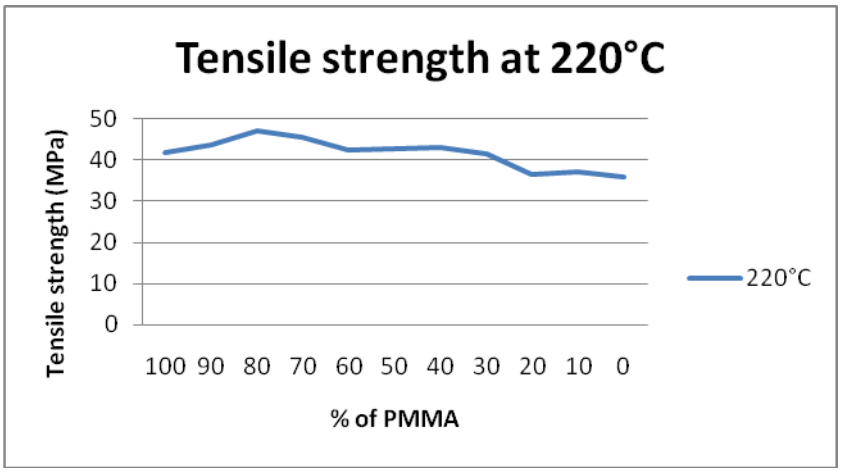


**Fig 3: Tensile strength of PMMA/SAN Blend at 220°C**

The tensile strength of PMMA/SAN blend increases with increase in SAN content up to 20%.after that the result showing a decreasing trend. The maximum tensile strength obtained is 47.13 MPa and the lower tensile strength for pure SAN. This graph does not show a steep decrease in strength from 80/20 blend to 20/70 blend after that the strengths of each blend are almost identical.

## IV. CONCLUSION

The PMMA/SAN blends were prepared in various concentrations and temperature and the tensile tests are conducted. The test result shows the addition of SAN up to 20% will increase the tensile strength and then decreases. The maximum tensile strength obtained is 51.4 MPa at 180°C. The PMMA/SAN blend at 80/20 ratio shows a synergetic effect and this effect of composites decreases with increase in SAN content. Higher temperature will cause thermal degradation of constituent blend which will cause decrease in tensile strength.

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