

PREPARATION AND CHARACTERIZATION OF POLYSTYRENE (PST) AND POLY VINYL CHLORIDE (PVC) ALLOYS.

ABSTRACT

Alloys of polystyrene (PST) and poly (vinyl Chloride) (PVC) were prepared by solvent casting techniques. These results were interpreted in terms of the interactions between the components of these blends. Physiochemical characteristics of the products were studied. It was found that at certain relative concentration, some of these properties were enhanced, while some degraded relatively to the constituent homopolymers. By means of FT infra red studies, it was established that functional groups were the major players in interactions. Other modes include dipole-dipole, van der waals and mere physical entanglements.

Keywords: PST, PVC, homopolymers, Physiochemical characteristics, casting techniques and relative concentration.

INTRODUCTION

Blending has remained one of the most active areas of growth in polymer materials. Advances in the production of high perform polymer-based compositions will in the future, more likely result from the utilization of few mixtures of polymers rather than from new polymers compositions. It has been said that blends have an enviable and continuing growth. The wide diversity of the applications for which it is put virtually guarantees a healthy business at least for the foreseeable future. It has also been predicted that by the end of this century, half of all engineering plastics will be blends or it is however argued that within this period and subsequently, plastics are destined to replace metals.

This trend can be supported by the fact that blends or alloys can be obtained from compatible (miscible) or incompatible (immiscible) polymers. According to some authors (9-10), miscibility or compatibility would be desirable for technological purposes because in completely immiscible blends, components separate into their respective phases limiting the effectiveness of the mechanical behaviour of the blends. Nevertheless other investigators (5-6), consider that better results might be obtained from incompatible polymer blends, due to the fact that, in this case, better properties will be determined by those of pure polymers, geometrical arrangements or the two phases, their morphology, extent of interpenetration and the nature of the interface (5). We have to point out that between “complete immiscibility” and “thermodynamic miscibility” there exist some different levels of compatibility; for example the so called “technological compatibility” where two phases exist but the blend behaves (in a microscopic sense) as unique material at industrial processing conditions. There are different methods of evaluating the miscibility of polymer blends(7).

Although many miscible polymer pairs have been identified, most combinations of polymers are immiscible. In many instances, phase-separated blends are preferred for achieving useful results. For example, such polymer-polymer composites yield materials whose stiffness can be adjusted, in principle, to any value between those of the component polymers. However, tailoring blends to achieve this or other characteristics require among other things, control over the spatial arrangement or morphology of the phases and some degree of stability once formed (1). These arrangements may consist of one phase dispersed as simple spheres in a matrix of the other polymer as shown in figure 1a. On the other hand the dispersed phase may take the form of fibrils or platelets with varying aspects ratios as shown in figure 1c and 1b respectively.

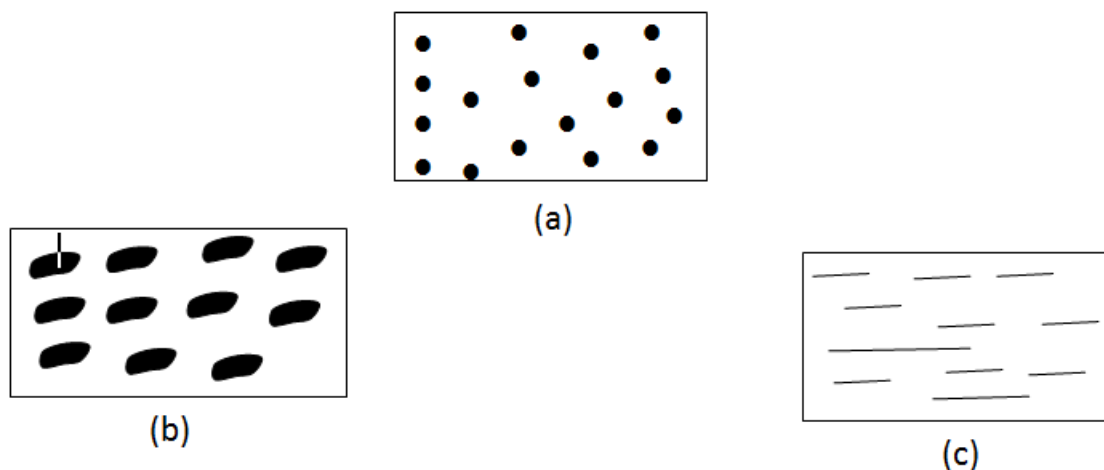


Fig.1: Different types of dispersion of a polymer in the matrix of an immiscible polymer.

The properties of polymer blends reflect a composition-weighted average of the properties possessed by the components. In general, the property dependence on composition varies in a complex way with the particular property, the nature of the components (glossy, rubbery or semi crystalline), the thermodynamic state of the blend (miscible or immiscible) and its mechanical state material for testing

There is no single “poly (vinyl chloride)” molecule. PVC is really a mixture of compounds with a range of molecular weights. For this reason, polymers are represented by placing the repeating unit derived from the monomer within a set of parenthesis. PVC is one of the world’s major bulk polymers. it owes its popularity to its versatility.

The polymer itself is chemically inert and non flammable, burning only in presence of a source of ignition. It is compatible with many additives, including plasticizers, heat stabilizers, lubricants, fillers, and other polymers. These additives enable the polymer to be processed easily by a wide range of techniques without the fear of degradation to produce articles with a variety of mechanical properties. The articles may be rigid, such as house sidings, rain gutters, and window frames, or flexible as in cable insulation, medical tubing, and plastic gloves. PVC is transparent and can be used in making clear bottle and sheets. Finally, it is one of the least expensive plastic resins (27,28).

Approximately 75% of the world’s PVC is produced by the suspension polymerization (S-PVC) process in which the polymerization is carried out inside vinyl chloride monomer (VCM) droplets dispersed in water. The product is in the form of porous 100-150um-diameter grains.

PVC is used as an insulator for cables and in the manufacture of ‘artificial’ leather (e.g car upholstery), household goods such as curtains and table clothes, of records (records generally) and floor coverings others include the use of PVC as garden hoses, ‘vinyl plastics’ films water pipes, table below can be used to illustrate more on the uses of PVC which stipulates the processing techniques and the PVC of rigid and plasticized type.

Polystyrene and styrene copolymers are noted for their high tensile strength and optical clarity but they are brittle under many normal use conditions. Rubber modification opens up many markets unavailable to unmodified polystyrene(23). The rubber-in – styrene polymerization usually results in a superior product when compared with blended products, that is, higher modulus and equivalent impact strength are achieved with less rubber. The property improvement is due to a chemical interaction (grafting) between the growing polystyrene chain and the rubber, chemical cross-linking of the rubber, and occlusion of the continuous-phase polymer inside the rubber particles, which increase the effective volume of the rubber phase. Rubber reinforcement produces other physical property improvements such as increased elongation, ductility and environmental stress crack resistance (ESCR). These improvements in the composite polymers

are accompanied by loss of clarity and a large decrease in tensile strength and modulus from the unmodified polymer. The properties of styrene-methacrylate copolymers generally fall between those of the individual homopolymers. Thus the weather ability and solvent resistance of this copolymers are superior to those of polystyrene homopolymer. Polystyrene has a wide application in the production/manufacture of toys, Styrofoam, plastics, foam insulation 'safeguard' materials for electronics products on packaging, among other useful applications.

MATERIALS AND METHODS

EQUIPMENT USED

Instron Tensile Tester Model 1000, Profile Enlarger Model 1091, Naber Electrical Furnance Model 2804 and FTF I.R-testing apparatus.

METHODS

The Instron testing equipment is a universal equipment and widely used as a standard quality control instrument. The Instron model 1000 was used in this research to test for force and extension at break of each samples, this was done by placing each of the films of different polymer compositions in between the upper and lower grip. Through the adjustment of the air control units, the films was held and placed in the right position for test to take place. Tensile strength which is the maximum stress or force/unit area in units of Nm⁻² was then determined and extensions at break which is the increase in sample length during a tensile test was also determined. It was expressed as a percentage of original length.

PROFILE ENLARGER

The profile enlarger Model 1091 was used to measure for thickness of films. This was done by placing the sample on its stand and adjusting the x and y-axis knobs which now place the samples in the right position for readings to be taken.

PST/PVC BLEND

MATERIALS AND SOURCES

PVC samples were supplied by Louis Cater industries Nigeria Limited, Nnewi, Anambra State, Nigeria. The safeguard materials for Electronics product on packing was used as PST.

PST/PVC METHODS

wt/wt solutions were made from both samples of polystyrene and polyvinyl chloride in benzene and 2-butanone respectively and cast as films on same mercury surface at room temperature. The solvent was allowed to evaporate very slowly under a stream of air. The resulting films were collected and characterized as described earlier. The blend percentage composition studied were as follows: (wt%) PST/PVC:0:100, 20:80, 40:60, 50:50, 60:40, 80:20, 100:0

RESULTS

TABLE 1: Summary of Properties of Films of PST/PVC Blends

Blend Composition								Film Properties	
PVC	PST	THICKNESS (M)	AREA (M ²)	FORCE (N)	NOMINAL STRESS (NM ⁻²)	EXTENSION AT BREAK (%)	MELTING POINT (°C)	SOLUBILITY IN 2-BUTANONE	SOLUBILITY IN BENZENE
100	0	1.03x 10 ⁻²	4.14 x 10 ⁻⁴	3	0.72 x 10 ⁴	-	261	Soluble	Insoluble
80	20	1.17x 10 ⁻²	8.39 x 10 ⁻⁴	12	1.43 x 10 ⁴	-	291	Soluble	Spriny Soluble
60	40	1.83 x 10 ⁻²	13.52x 10 ⁻⁴	75	5.55 x 10 ⁴	25	289	Soluble	Spriny Soluble
50	50	1.61 x 10 ⁻²	11.27x 10 ⁻⁴	75	6.65 x 10 ⁴	30	270	Soluble	Spriny Soluble
40	60	1.57 x 10 ⁻²	10.19 x 10 ⁻⁴	77	7.56 x 10 ⁴	50	258	Soluble	Spriny Soluble
20	80	0.91 x 10 ⁻²	5.25 x 10 ⁻⁴	48	9.14 x 10 ⁴	75	254	Soluble	Soluble
0	100	1.37 x 10 ⁻²	6.16 x 10 ⁻⁴	183	29.70 x 10 ⁴	80	205	Soluble	Soluble

Table 2 PST/PVC (wt%) blend results for I.R at benzene ring band.

PST	PVC	Frequency (Cm ⁻¹)	Transmittance (%)	Δ T (%)
100	0	906.55	1.35	0.00
80	20	752.52	3.81	2.46
60	40	750.71	0.35	-1.00
50	50	842.29	0.08	-1.27
40	60	842.24	0.46	-0.89
0	100	747.51	0.84	-0.51

DISCUSSION

TENSILE STRENGTH AGAINST BLEND PROPORTIONS

Table 1 shows the result of tensile strength against base mole fractions of PVC/PST blends. It was observed that the tensile strength of PVC was low, but increased with the addition of PST. This shows that the plasticity of PVC can be a bit hardened by blending with PST. This implies also, that blending of PVC with PST can be used to make a very hard polymeric material, depending on the concentration of PST.

EXTENSION AT BREAK AGAINST BLEND PROPORTIONS

The extension at break against the base mole fractions of PVC/PST blends in table 1, shows that blends of 100% and 80% PVC are brittle. The extensibility of the blends increased sharply with an increase in PST contents.

MELTING POINT (TM) AGAINST BLEND PROPORTIONS

Table 1: shows the plot of melting point against base mole fractions of PVC/PST blends. It was observed that increase in PST contents decreases the melting point of the blends while increase in PVC contents, increases highly the melting point of PVC/PST blends. This is because of the interaction due to the entanglement between the molecules of the polymers at different blend compositions.

SOLUBILITY OF THE BLEND PROPORTIONS

Table 1 shows how soluble the polymer blends are when a particular quantity of the blend was dissolved in 10cm³ of 2-butanone and benzene respectively. PVC/PST blends were generally soluble in 2-butanone while it was soluble and sparingly soluble in benzene.

RESULTS OF INFRA RED (IR) TEST ON BLEND PROPORTIONS FT

Infra red testing apparatus can be used to determine the structure of organic compounds, identify the presence of certain functional groups within a molecule and monitoring of the rate of interaction in a compound. For this research, it was used to determine the concentration of maximum interaction in PST/PVC blends. The C = O absorption band of saturated aliphatic esters is in the 1750-1735cm⁻¹ region that of aryl esters at 1730-1715cm⁻¹ but C=O at different blends proportions because of the presence of PVC and PST. Maximum interaction and efficiency can be obtained at 80/20 and 100/0 concentrations PST/PVC blends respectively as shown in table 2. At this concentration, the blend is of high strength and extensibility.

CONCLUSION

In conclusion, the results from the above results showed that maximum interaction and efficiency of the PST/PVC blends were achieved at 80/20 and 100/0 concentrations of PST/PVC respectively.

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