

Effect of Solvent Pretreatment of Polyester at Varying Temperature and Time on the Glass Transition Temperature

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Abstract - The glass transition temperature of a polymer such as Polyethylene terephthalate is found to alter significantly as a result of modification to its structure. Polyethylene terephthalate was pretreated in ten organic solvent at 30°C and 50°C for 30, 60, 120, 300 and 900 seconds respectively. The T_g of the samples were tested which was found to alter significantly with marked results obtained on samples treated with Benzyl alcohol.

Key words: Polyester, Solvents, Pre-treatment, Glass Transition Temperature (T_g)

INTRODUCTION

The transition temperatures of polymers are very important to determining the behaviour of the polymers at production, processing and use. They serve as guide into how the polymer performance can be predicted. The identifiable transition temperatures are: the glass transition temperature (T_g), melting temperature (T_m), crystallization temperature (T_c) and degradation temperature (T_d). The peculiarities of these temperatures are significant. The gap difference between the glass transition temperature (T_g) and the next transition temperature (T_m) is very wide. The lower the T_g for polyethylene terephthalate (PET) and the easier it is for processing handle where heat application is required. As a result of this, chemists try to work on this aspect either physically or mechanically or chemically or a combination of both. Chemical treatment leading to physical or mechanical modifications are the target of this study.

The physical states of a polymer have been identified to change as a result of treatment given to the polymer. Solvent treatment on polyester have been studied by a number of workers as a means of ensuring detailed study of the polymer characteristics. Popoola 1983, studied the effect of DMF treatment on polyester structures. Brenneck and Richter 1959, studied the swelling of polyester in various organic solvents. The glass transition temperature T_g is the onset of extensive molecular motion in an amorphous region. T_g is the most important parameter of an amorphous polymer, for it determines whether the materials will be hard solid or an elastomer in conventional use and at what temperature the behaviour changes. It is very important in partially crystalline polymers since it frequently gives an indication of an embrittlement temperature. Polyethylene terephthalate (PET) is a 35-49% crystalline in nature with no positive or negative charges in its structures. The polymer is hydrophobic with less than 1% moisture absorptive capacity which exhibits very small extent of swelling in water of which most of its treatment processing takes place (Walawska, et'al, 2003).

MATERIALS AND METHOD

The polyethylene terephthalate polymer fibre used for this study was treated in a 3-neck solvent treatment flask at 30°C and 50°C for 30s, 60s, 120s, 300s and 900s respectively. The samples are then dried at 70°C and the glass transition temperature determined using a melting point apparatus.

RESULTS / DISCUSSION

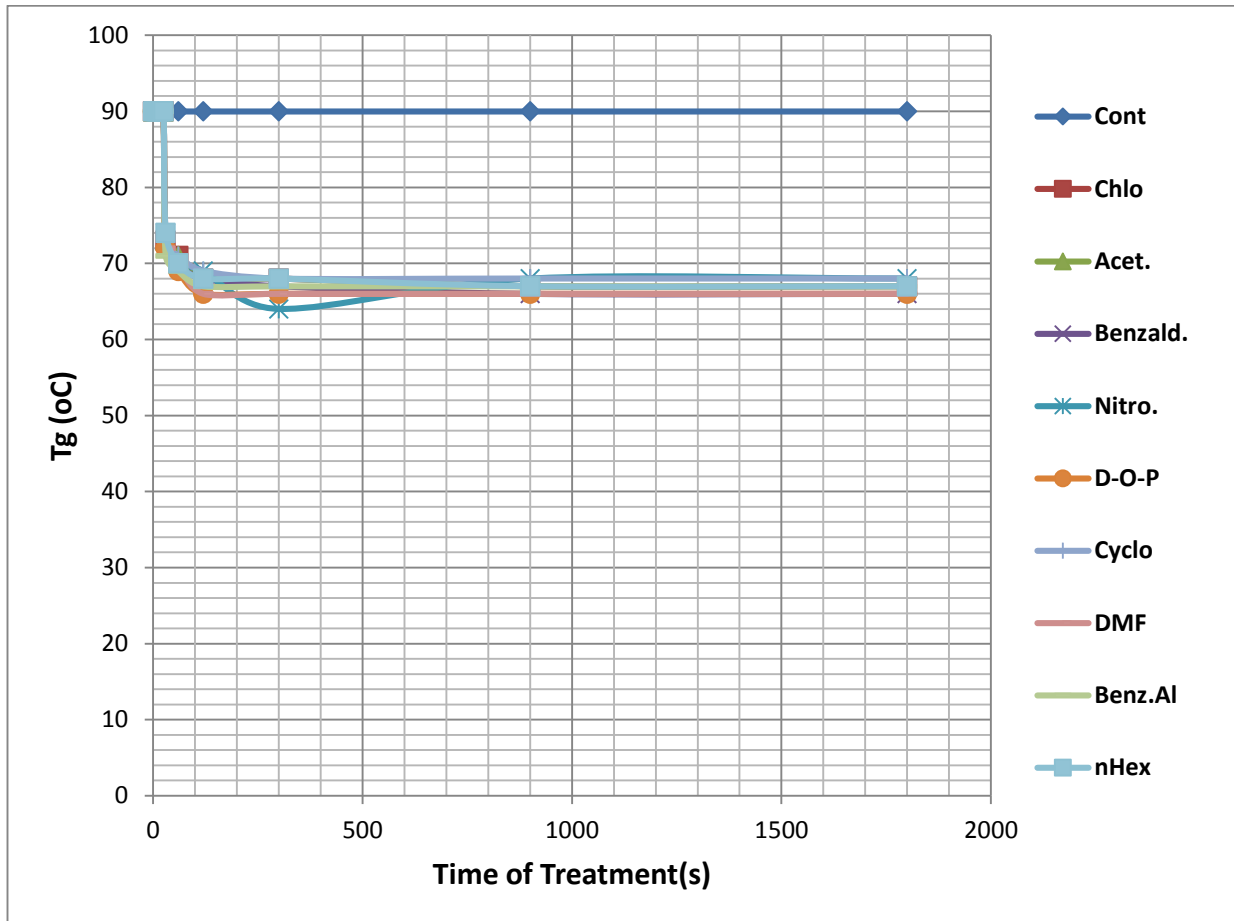


Figure 1 showing the Measured Tg at 30°C Pretreatment Temperature

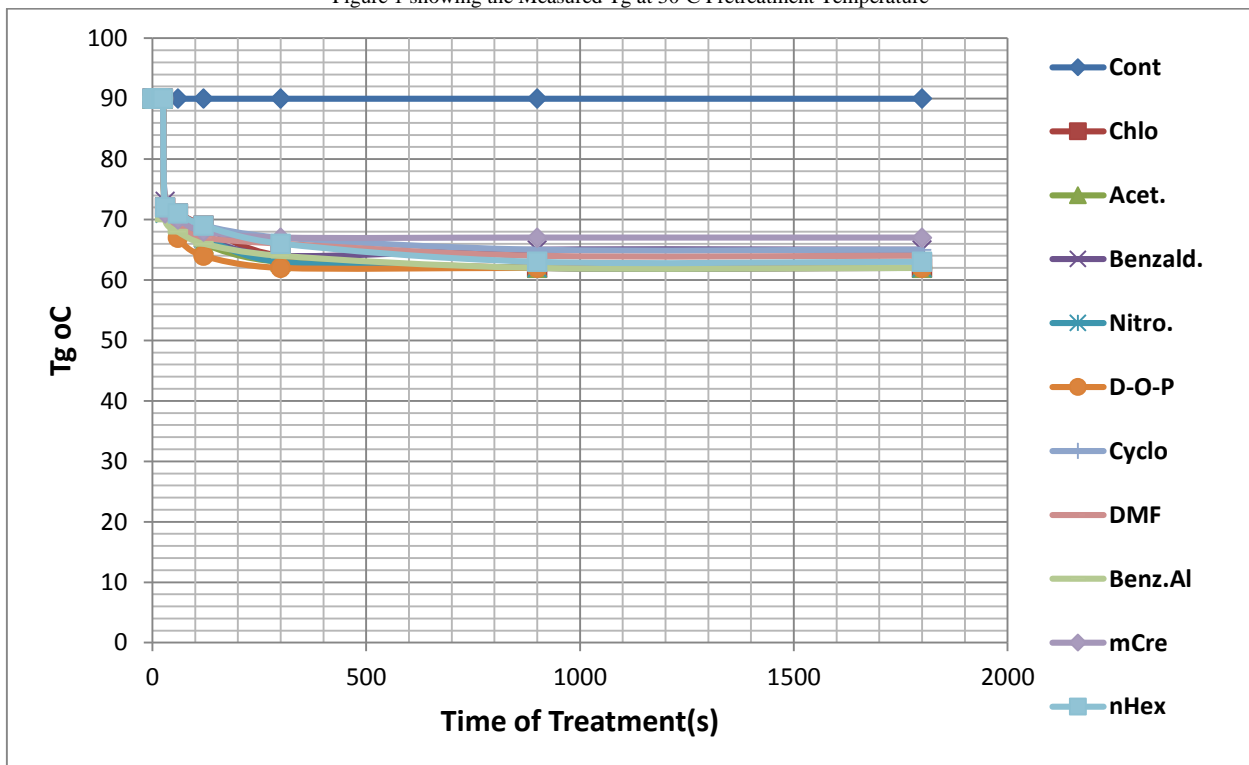


Figure 2 showing the Measured Tg at 50°C Pretreatment Temperature

The effect of the amount of liquid retention on the measured Glass Transition Temperature (T_g) is a function of temperature of treatment but time and principally the amount of liquid retained. The attributes of the control (i.e untreated samples) shows that the glass transition temperature is about 90°C. The high T_g value is due to the effect of drawing and texturing on the development of crystallinity in the untreated fibre. A mixture of highly crystalline and amorphous regions are obtained due to the texturisation state of the original sample. The structure is probably micellar with deformation concentrated in the amorphous regions mainly.

At 30°C pretreatment temperature, the measured glass transition temperature (T_g) was least for benzaldehyde and dimethyl-o-phthalate i.e 66°C after 900seconds solvent interaction. However, at 50°C pretreatment temperature the least value was 62°C for chloroform, acetone, nitrobenzene, and benzyl alcohol. This is an indication that at higher temperature of solvent treatment, there is a greater segmental friction or mobility, which influences the rate of all configurational rearrangements of the polymer fibrillar structure similar to the observation of Williams et'al, 1955. The glass transition temperature (T_g) of polyester cannot be observed from the two – components of aliphatic sequence chains – O.CO.CH₂CH₂.CO.O- while the higher glass transition temperature will be attributed to the benzene rings which are stiffer and probably interact together. The drop observed in figures 1 and 2 from 90°C for untreated to 74°C and below in the various solvents were as a result of chain strain which the polymer fibrillar structures were relieved off by the action of solvents. This

is observed to be highest for benzyl alcohol at 50°C pretreatment temperature. The lower the measured temperature i.e T_g, the better the polymer state prior to dyeing and the lower the temperature at which the processing temperature of dyeing can be carried out.

CONCLUSION

As a result of solvent treatment of the polyethylene terephthalate lower T_g is achieved. Solvent pretreatment at lower temperatures lowers the T_g minimally while at 50°C greater segmental friction or mobility of the polymer molecules is achieved which influences the rate of all configurational rearrangements of the polymer fibrillar structure. Relief of chains strains as a results of solvent action is prevalent at higher temperatures.

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