Study on Mechanical Properties of Polyester with Addition of Recycle Gift or Members Card

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Abstract. Increasing usage of gift cards will end up increasing the waste. Instead of throwing in the dustbin, re-cycling the cards may help in increasing the product usage and contribute to the environment sustainability. In this study, the re-cycle gift cards were combined with polyester to produce polymer blend. The composition of re-cycle gift cards was 2, 4 and 6 wt%. The gift card was crush and mix with the polyester and hardener followed by casting to get the suitable shape based on the testing. Three testing was undergone to evaluate the polymer blend properties which are tensile test, Charpy’s impact test and Durometer hardness test. Similar trend was shown for all mechanical testing which showing an increase of performance from 2 to 4 wt% addition of recycle cards but reduce when achieved 6 wt%.

1 Introduction

A gift cards is a new trend of giving present instead of physical gifts. A lot of shopping mall, boutique and store are still using members’ cards compares to phone applications. Those cards are everywhere and cannot be re-used. Thus, there is an interest of recycling these cards rather than just throwing in the bin.

Plastic industrial and others product based on polymers have been one industrial sector that contribute to economic structure everywhere. Now, we can see that products based on polymers has widely use as raw material to produce variety of product. The advanced polymer is creating to produce special characteristics such as heat resistance, skid resistance, high stamp resistance, and it also environmental resistances. Usually, the added polymers with other kind of additive materials works to improve the characteristic, solve the problems of the original polymers as well as sustainable development.

Textile and plastic industry were using polyester vastly. Polyester have been popular due to its durability and chemical resistance. The utilization of a gift cards has become trending as a change of physical gift. By using the gift cards, peoples are freely choosing

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their favorite gift based on their interest and requirement. The gift cards always thrown away after used.

Polymer Blend is a combination of at least two polymer or co-polymer by physical mixture without any chemical bonding. It may be divided into three categories; i) Immiscible or heterogeneous polymer blends, ii) Compatible polymer blends and iii) Miscible or homogeneous polymer blends [1, 2]. Polymer blending is one of a smart method for producing new polymeric materials. This method offers variety of advantages such as enhancing resin performance, improving specific property, and plastic re-cycling [3]. The performance of the polymer blend is targeted to the maximum performance of the materials and this kind of materials is expected to withstand several conditions; thus, further study of the polymer blend is crucial to evaluate its properties and performance [4].

2 Methodology

The materials used in this study was polyester and particulate of the gift card. The gift card was collected from polymer-based materials. The hardener was added with ratio 1:100 to the polymer. The percentage of the gift cards was 2 wt%, 4 wt% and 6 wt%. The pure polyester sample was also prepared as a control sample. The cards were crushed using a granulator and High-Speed Rotor Mill Machine to produce ≤ 200μm size. All materials were mix using a hand mixer and cast into the mold according to the testing standard. The mixing was left up to 4 hours before removing from the mold. For each testing, at least three samples were used to calculate the average value for each composition.

Three types of mechanical testing were done to evaluate the effect of adding the gift cards to the polyester which are tensile testing, Charpy’s impact testing and Durometer hardness test. For tensile test, the tensile strength and Young’s modulus of the sample was measured according to ASTM D638. The Charpy’s impact test was done according to ASTM D625 standard. While for Durometer hardness test, ASTM D2240 was referred and Shore D was used. Table 1 shows the samples size for mechanical testing.

| Mechanical testing | Tensile testing (ASTM D638) | Hardness testing (ASTM D2240) | Impact testing (ASTM D256) |
|-------------------|-----------------------------|-----------------------------|-----------------------------|
|                   | Universal Testing Machine   | Durometer                   | Impact Tester               |
| Length            | 165 mm                      | 60 mm                       | 80 mm                       |
| Wide              | 19 mm                       | 10 mm                       | 10 mm                       |
| Thickness         | 4 mm                        | 6 mm                        | 9 mm                        |
| Gauge             | length                      |                             |                             |
|                   | 50 mm                       | -                           | -                           |
|                   | 13 mm                       | -                           | -                           |
| Notch             | -                           | -                           | 45°                         |
| Depth             | -                           | -                           | 1-3 mm                      |
3 Results and Discussion

Table 2 shows the average results for tensile test. It is found that increasing the gift card percentage from 2 wt% to 4 wt% will increase nearly 40% of the Young’s modulus and 20% of the ultimate tensile strength of the polymer blend. This may be due to the homogeneous physical nature between the two polymers [5, 6]. However, addition of 6 wt% card decreased the tensile properties of the polymer blend. This is possibly due to the agglomeration of the cards and large particle size of the card [7] which results in un-homogeneous stress distribution thus reducing the polymer blend strength. The higher composition of the cards reducing the wettability of polymer and may producing internal cracks that reducing the performance of the blend [8]. Comparing the polymer blend with 100% polyester, the polymer blend properties was increased.

Table 2: Polyester and polymer blend tensile properties

| Composition            | Elongation at break (mm) | 0.2% offset yield stress (MPa) | Ultimate Tensile Strength (MPa) | Young’s Modulus (MPa) |
|------------------------|--------------------------|--------------------------------|---------------------------------|-----------------------|
| 100% Polyester         | -                        | 2.263                          | 22.348                          | 32.055                | 899                   |
| 98% Polyester 2% gift card | -                        | 1.702                          | 24.028                          | 27.996                | 908                   |
| 96% Polyester 4% gift card | % ± compare to 100% polyester | +24.80% | +7.50% | +5.22% | +1.05% |
| 94% Polyester 6% gift card | % ± compare to 100% polyester | +27.11% | +34.23% | +24.76% | +41.55%  |

Figure 1 shows the impact strength of sample. The polymer blend shows increase in impact strength compare to the polyester alone as similarly found by previous researcher [9].
Fig. 1: Impact strength of the polymer blend

The impact strength increase from 2 wt% to 4 wt% follow by decreases at 6 wt%. Increasing in impact strength showing the ability of the cards particle withstand the applied load by increasing the surface area. However, increases the percentage up to 6 wt% showing inability of the card particle to blend with the polymer and act as the stress concentration in the blending and results in slightly decrease in the impact strength as also discuss by Sallal et al. [10].

For Durometer hardness test (Figure 2), similar trends as impact strength was shown. As the cards composition increase to 2 wt%, the hardness increase 2.3 % and with addition of 4 wt% the hardness increase 5% compares to pure polyester. Similar trend was also found by Hameed and Fahad [11] which addition of PVC to epoxy and unsaturated polyester. However, increasing the composition to 6 wt% slightly decreased the hardness, although it is somewhat higher than pure polyester. This is due to unreacted bond which results in difficulty for the molecule to be cured, as discuss previously [12].
Conclusion

It can be concluded that adding the card may improve the polymer blends property compared to pure polyester. Similar trend was found for all properties which increasing the card composition from 2 wt% to 4 wt% will increase the tensile strength, Young’s modulus, impact strength and hardness of the polymer blend. However, another addition of the cards up to 6 wt% will slightly decrease the polymer properties although higher than pure polyester. So, the optimum composition of the cards for this mixture is at 4 wt%.

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