Evaluation of Physical Properties of Recycled Polyethylene Waste Films and Application of its Carbon filled Composites as Anti-static Material in Electronic Packaging

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Introduction

Polyethylene (PE) is used in film packaging application in our day-to-day life those we throw outside or inside the dustbin. These waste polyethylene's are recycled and again reused for packaging purposes. In most cases, these waste polyethylene's are recycled without adding any extra additives within it and are used for the same purposes. However, by adding some other additives/ fillers within it, one can recycle these polyethylene's, and can be used as antistatic material. An antistatic material is a material which is used to reduce static electricity to protect electrostatic sensitive devices. The development of static charge can destroy sensitive electronic components etc. Hence, the development of antistatic material is necessary to protect the electronic equipments. The antistatic material is made of that material which either is itself slightly conductive or by making the surfaces of material/the material as a whole slightly conductive with the addition of external conductive additives. Ahmad has studied the recycling of PE waste to produce plastic cement [1]. There are also report of recycling of plastics in the past [2, 3]. However, the use of recycled PE as antistatic material is really scanty.

Materials and Methods

Materials Used

- Waste Polyethylene (PE)
- Printex XE2 Carbon Black (C)
- Solvent Toluene

Table 1. Formulations of PE/Black Composites

SN	Weight in php (per hundred of polymer)	
	PE	Printex Black
PEC0	100	0
PEC0.25	100	0.25
PEC0.50	100	0.50
PEC1	100	1
PEC2	100	2
PEC4	100	4
PEC6	100	6
PEC8	100	8
PEC10	100	10

Composite Preparation

Solution Preparation of PE

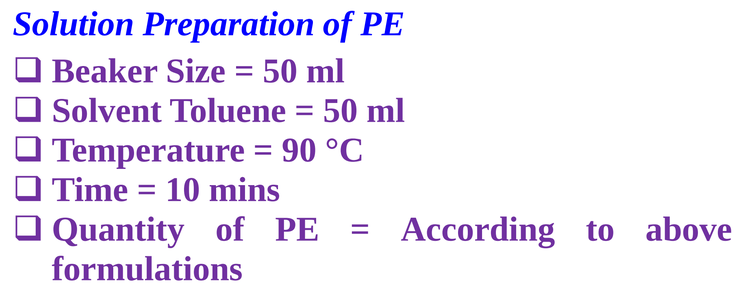
- Beaker Size = 50 ml
- Solvent Toluene = 50 ml
- Temperature = 90 °C
- Time = 10 mins
- Quantity of PE = According to above formulations

Mixing through Probe Type Sonicator

- Beaker Size = 50 ml
- Toluene = 50 ml
- Sonicator Horn Amplitude = 10%
- Sonication Time = 40 mins
- Pulse = 0.5 sec on-off
- Temperature = 90 °C
- Quantity of Materials = According to above formulations

Evaporation Process

- Method = Solvent casting
- Petridis Size (diameter) = 90 mm
- Evaporation Temperature = 90 °C
- Evaporation Time = As required



PE in toluene PE+CB in toluene Composite film

Figure 1. Preparation method of composites

Characterizations

- Ultra Violet (UV)-VIS Spectra
- Electrical Resistivity
- Scanning Electron Microscopy (SEM)

Results and Discussion

UV-VIS Spectra

- UV-VIS spectra was carried out to check the optimum sonication time for PE/black composites.
- At the effective dispersion of carbon black, the particle aggregates are disappeared and there is the superimposition of spectra as shown in the Fig. 2.
- The optimum time of sonication was determined as 40 min for the composites.

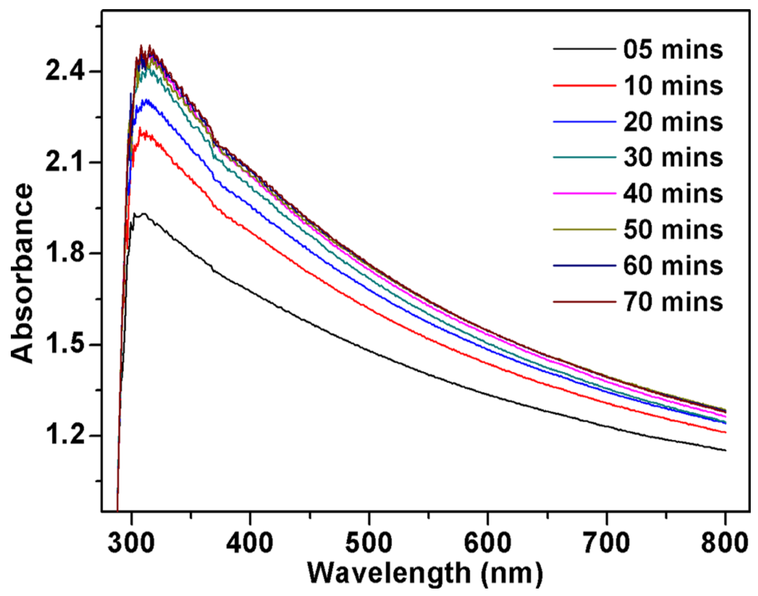


Figure 2. UV-VIS spectra of PEC4 composites at different time interval in the range 200-800 nm.

Electrical Resistivity

- Electrical resistivity within the range 10^{17}-10^{12} ohm-cm is insulator, 10^{12}-10^{8} ohm-cm is anti-static and below 10^{8} ohm-cm is semiconductor /conductor.
- It was found that the electrical dc resistivity decreases with the increase in black loading in the composites as shown in the Table 2.
- This decrement is due to the formation of conductive continuous network of carbon black particles within the polymer matrix.

Table 2. DC resistivity of PE/carbon composites

SN	Resistivity (ohm-cm)
PEC0	8.75×10^{16}
PEC0.25	2.65×10^{15}
PEC0.50	3.26×10^{13}
PEC1	4.93×10^{11}
PEC2	5.56×10^{9}
PEC4	2.98×10^{7}
PEC6	7.64×10^{3}
PEC8	4.68×10^{2}
PEC10	2.44×10^{2}

Scanning Electron Microscopy (SEM) Study

- The SEM study is carried out to check the proper dispersion and distribution of carbon particles within the polymer matrix.
- The image (Fig. 3) shows that the carbon particles are almost evenly distributed within the polymer matrix.
- Polymer composite shows network formation of carbon black particles within the polymer matrix.

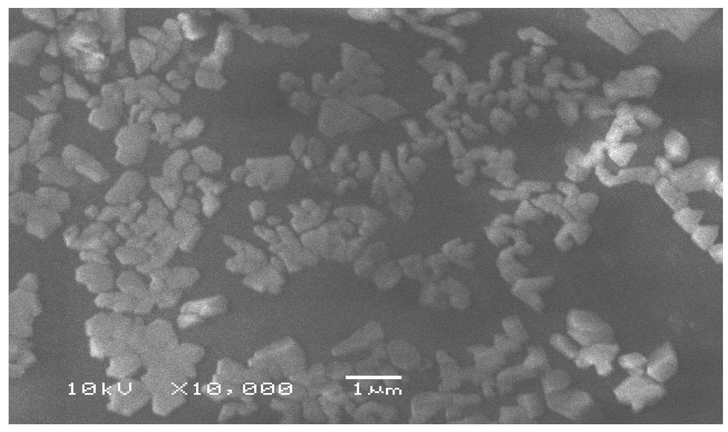


Figure 3. SEM images of PEC6 composite film prepared by solvent evaporative casting.

Conclusions

- UV spectra analysis reveals that the optimum sonication time is 40 mins for the composites.
- SEM analysis shows good dispersion of black particle within the polymer matrix.
- The composites those electrical resistivity falls in between 10^{12}-10^{8} ohm-cm , can be used as anti-static materials for electronic packaging.
- Plastics waste can be managed and recycled in this manner to prevent environment.

Acknowledgement

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