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Structural and Morphological Transformation of LDPE after Incorporation of PEG

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Abstract: *PEG incorporation significantly changes the structural and morphological properties of LDPE.The structural and morphological properties were analyzed using X-ray diffraction,Fourier-Transform infrared spectroscopy (FTIR) ,and scanning electron microscopy (SEM). XRD results revealed a reduction in crystallinity, while FTIR confirms the successful incorporation of PEG in LDPE.More uniform,smooth and spherical microparticles instead of irregular and aggregated obtained from SEM. PEG work as a stabilizer and size controlling agent.*

Keywords: LDPE, PEG, Nanoprecipitation ,Morphological Transformation, Structuaral Properties

I. INTRODUCTION

Polyethylene (PE) based materials are widely used in many fields due to the combination of excellent physical and chemical properties along with low cost**.** Hence, to develop the PE-based materials functionalized by polar groups such as glycols or polymer segments with some improved or modified properties.[1]

Low-density polyethylene is an incompletely crystalline solid with a degree of crystallinity in the 50–60% range that leads to several properties such as opacity, tensile strength, tear strength, rigidity and chemical resistance, flexibility even at a low temperature[2]

Low-density polyethylene (LDPE) is widely used in food packaging because of acceptable flexibility, transpar ency, easy processability, thermal stability, environmentally recyclability, and inexpensive properties[3]

Low density polyethylene is among the most versatile polymers, but its uses are limited due to several drawbacks, namely low strength, stiffness and poor heat resistance. To overcome these drawbacks and to prepare material with improved properties, fillers are incorporated into the matrix. Fillers can affect the dimensional stability, crystallinity, mechanical and other properties of polymers.[4]

Polyethylene glycol (PEG), also known as macrogol, is a poly ether consisting of ethoxy units derived from the ring-opening polymerization of ethylene oxide. The traditional PEG is a linear polymer with chemically active hydroxyl groups at both ends, making it easy to conjugate with functional groups,[5]

Polyethylene glycol (PEG) is a synthetic, versatile, and highly hydrophilic polymer with different chain lengths and numerous functional end groups. PEGs are highly soluble in many organic solvents such as methanol, ethanol, and dichloromethane. Therefore, their end groups are easy to be modified and this modification is important to increase their applications[6]

Nanoprecipitation is also called solvent displacement or interfacial deposition. It is considered as one of the first developed techniques used for the encapsulation of drug molecules. This technique was developed by Fessi et al. (1989). Since its develop ment, the technique has been widely used for the encapsulation of mainly, hydrophobic drugs in either nanocapsules or nanospheres[7]

A typical nanoprecipitation process involves mixing a polymer solution dissolved in an organic solvent with an aqueous solution. When the organic solution containing polymers rapidly and uniformly mixes with the aqueous non-solvent, it

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crosses the solubility barrier, resulting in the precipitation or phase separation of the solute into nanoparticles within the continuous phase[8]

This research aims to investigate the structural and morphological changes in LDPE after incorporation of PEG by nanoprecipitation methods.Analyze structural changes using FTIR and XRD,and evaluate morphological transformation by using SEM.

II. MATERIALS AND METHODS

2.1 Materials

Low density polyethylene(LDPE),Polyethylene Glycol (PEG),Xylene(AR grade),distilled water,magnetic stirrer and hot plate,syringe,sonicator.

2.2 Methods

For preparation of solution LDPE and PEG dissolved in 40 ml xylene at 100-110^{0}c with constant stirring until a clear solution formed,for preparation of non solvent take distilled water.The hot LDPE and PEG solution was injected dropwise into water using syringe.Rapid mixed caused immediate precipitation.The dispersion was sonicated for 20-30 min.to breke aggregates ,then filtrate,washed and dried at room temperature.

III. RESULTS AND DISCUSSION

3.1 FTIR structural analysis

FTIR is used to detect structural interactions between LDPE and PEG

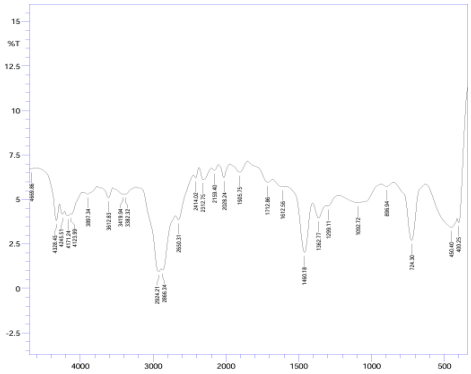

Fig.3.1 (a) FTIR spectra of LDPE

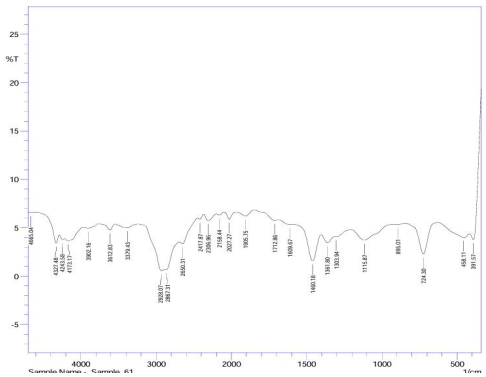

Fig.3.1 (b) FTIR spectra of LDPE/PEG

FTIR spectra of LDPE shows characteristics peaks at 2924.21 cm $^{-1}$ and 2866.34 cm^{-1}due to asymmetrical and symmetrical CH stretching vibrations of LDPE.A peak at 3420 cm $^{-1}$are corresponds to OH stretching vibrations of hydroxyl groups from PEG. Slight variation in position of peaks which is due to incorporation of PEG.Peak shifing indicated improved intermolecular interactions

3.2 XRD analysis

XRD is used to study crystallinity and structural changes after PEG incorporation

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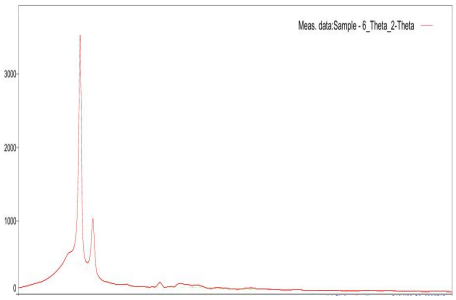

Fig.3.2 (a) XRD of LDPE

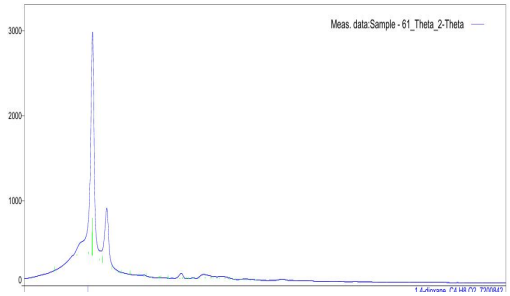

Fig.3.2(b) XRD of LDPE/PEG

LDPE showed sharp crystalline peaks at 21.33^0 and 23.67^0. PEG added in LDPE showed peak broadening and reduced intensity indicating decrease in crystalline size.[9]

3.3 SEM morphology

SEM was used to observe particle shape,surfae morphology and size distribution.

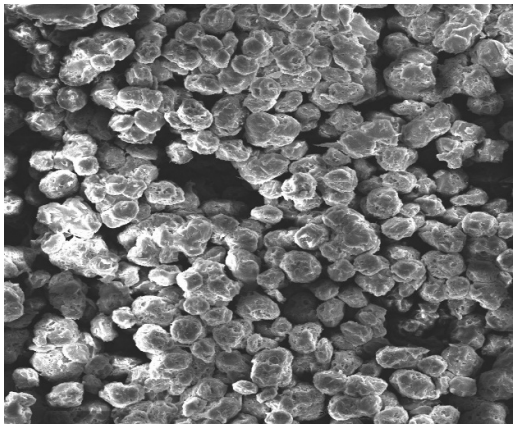

Fig.3.3 (a) SEM images of LDPE

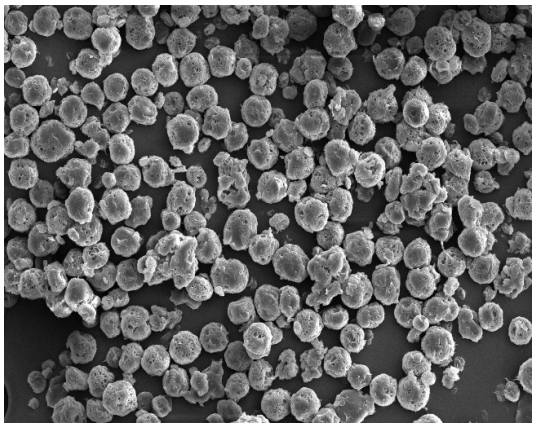

Fig.3.3(b) SEM images of LDPE/PEG

LDPE shows irregular particle shape with large aggregatess and rough surface. PEG added in LDPE having uniform spherical shapes with smooth morphology and reduced aggregation.Thus PEG work as a stabilizer and size controlling agent.

IV. CONCLUSION

PEG significantly improved structural and morphological properties of LDPE.PEG incorporation stabilized dispersion and improved inter chain interaction, reduced crystallinity, enhanced uniform spherical particle formation ,

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