

# Modern Technology of Plastic & Polymer Processing Industries

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The Indian plastic and polymer industry has taken great strides. In the last few decades, the industry has grown to the status of a leading sector in the country with a sizable base. The material is gaining notable importance in different spheres of activity and the per capita consumption is increasing at a fast pace. Continuous advancements and developments in polymer technology, processing machineries, expertise and cost effective manufacturing is fast replacing the typical materials in different segments with plastics. Plastics play a very important role in our daily lives. Throughout the world the demand for plastic, particularly plastic packaging, continues to rapidly grow. Polymer processing industry deals with the manufacture and production of polymer and synthetic substances for example acrylic plastics: poly (methyl methacrylate), poly vinyl chloride (PVC), polyamides, polyesters, cellulose plastics etc. Plastic is incredibly versatile and can be made from different ingredients, moulded into any shape, and put to a huge range of uses across industry and the rest of society. Polymer Energy system is an award winning, innovative, proprietary process to convert waste plastics into renewable energy. Polymers are the most rapidly growing sector of the materials industry. No wonder polymers are found in everything from compact discs to high tech aerospace applications. On the basis of value added, Indian share of plastic products industry is about 0.5% of national GDP.

This book majorly deals with properties and applications of engineering, the strength of thermoplastic composites, and the application of thermoplastic structural composites, applications of differential scanning, calorimetry and polymer characterization, polymer degradation and stabilization, advances in photo degradation and stabilization of polyurethanes and so on. This book also consists of raw material suppliers for plastic and plastic products, manufacturers of plastic processing machinery, plastics processing machinery and equipment (foreign), machinery and equipment for plastic converting, extruders and extrusion lines, injection moulding machines and so on.

This book offers, in standardized and readily accessible information on the synthesis, structure, properties and applications of the most important polymeric materials. It has been designed as a text giving a balanced coverage of the science and technology of polymers finding major applications plastics. This book is very useful for industrialists, consultants, research scholars and institutes.

## 1. PROPERTIES AND APPLICATIONS OF ENGINEERING THERMOPLASTICS

Polyethylene Terephthalate (PET)

Applications

Polybutylene Terephthalate (PBT)

Characteristics

Applications

Polyamides (PA)

Characteristics

Applications

Polyoxymethylenes (POM)

Characteristics

Applications

Polycarbonate (PC)

Characteristics

Applications

## 2. THE STRENGTH OF THERMOPLASTIC COMPOSITES

Compression strength

The Tensile Strengths of Uniaxial Laminates

The Tensile Strengths of Cross-ply Laminates

Shear Strengths

Technological Tests

## 3. TEMPERATURE SENSITIVITY

The Effect of Temperature on Stiffness

The Influence of Temperature on Strength

Toughness and Temperature

Fire Resistance

## 4. THE APPLICATIONS OF THERMOPLASTIC STRUCTURAL COMPOSITES

Medical uses

Satellites and Launch Vehicles

Aircraft Structures

Marine applications

Automotive Engineering

Industrial Machinery

## 5. THERMAL ANALYSIS OF POLYMERIC MATERIALS

Dielectric Analyzer

Thermogravimetric Analysis (TGA)

Thermograms

High Resolution Thermogravimetric Analysis

Applications

Relative Thermal Stability

Differential Scanning Calorimetry (DSC)

## 6. APPLICATIONS OF DIFFERENTIAL SCANNING

## CALORIMETRY AND POLYMER CHARACTERIZATION

Specific Heat Capacity Measurement

Calculations

DSC Curing Kinetics

Principle of Operation

Applications

DSC Thermal Stability Kinetics

Applications

Degree of Crystallinity and Melting Point ( $T_m$ )

Statement of the Problem

## 7. KINETIC STUDIES WITH DIFFERENTIAL SCANNING

## CALORIMETER

Borchardt and Daniels Method

The Technique Assumes

ASTM E698 Method

Isothermal Method

Dynamic Versus Isothermal Method

Autocatalyzed versus Nth Order Kinetics

Theory and Calculations

Isothermal Method

## 8. THERMOGRAVIMETRY

Quality control and materials characterisation in the ceramics industry

Use of TGA to distinguish flame-retarded polymers from standard polymers

Measurement of Smoke Density by TGA/Photometric Analysis

TGA decomposition Kinetics

Applications

## 9. MOLECULAR WEIGHT AND DIMENSION OF POLYMERS

Concept of Average Molecular Weight

Molecular Weight Distribution

Measurement of Molecular Weight Average

Summary

## 10. POLYMER DEGRADATION AND STABILISATION

Types of Degradation

Other Types of Degradation

Recent Progress in the Degradation of Polyisobutylene

Introduction

Photodegradation

Oxidative Degradation

Stabilization

Sensitization

Advances in Photodegradation and Stabilization of

Polyurethanes

Introduction

Mechanism of Photodegradation

Effect of Physical State on Photodegradation

Photostabilization of Polyurethanes

Conclusion

New Developments in the Degradation, Stabilization, and

Sensitization of Poly (Methyl Methacrylate)

Introduction

Weathering

Plasma Degradation

Mechanical Degradation

Ultrasonic Degradation

Electrochemical Degradation

Radiative Degradation

Thermal Degradation

Photodegradation

Oxidative Degradation

Stabilization

Sensitization

## 11. CONDENSATION POLYMERIZATION OR STEP-GROWTH POLYMERIZATION

Functionality Principal

Types of Polymerization

Basic Characteristics of Condensation or Step-Growth

Polymerization

Formation of a Polyester

Relationship between Average functionality, Extent of Reaction and Degree of Polymerization

Molecular Weight Control: Quantitative Effect of Stoichiometric Imbalance on Maximum Attainable Molecular Weight

Kinetics of Step-growth Polymerization

Principle of Equal Reactivity of Functional Groups

Rate of Step-growth Polymerization

Distribution of Molecular Weight in (Linear Bifunctional Polycondensation

Derivation of Distribution Functions

Weight Average Degree of Polymerization

Multichain Step-Growth Polymers (Polyfunctional Systems)

Branching

Cross-linking

Prediction of Gel-Point

Some Additional Considerations of Non-Stoichiometric Reactant Systems

Practical Consideration of Gel Points

Molecular Weight Distribution in Multifunctional Reactant Systems

Interfacial Polymerization

## 12. COPOLYMERIZATION AND TECHNIQUES OF POLYMERIZATION

Concept of Copolymerization

Binary Copolymerization of Vinyl Monomers by Free Radical Mechanism

Analysis of the System and the Reactions Involved

Kinetics of Chain Propagation in Binary Copolymerization and Copolymer Composition

Significance of Monomer Reactivity Ratios

Types of Copolymerization

Ideal Copolymerization

Alternating Copolymerization

Azeotropic Copolymerization

Average Copolymer Composition

Determination of Monomer Reactivity Ratios

Rate of Copolymerization

Structure and Reactivity of Monomers and Radicals

Structure and Reactivity of Monomers

Resonance Stabilization

Radical Reactivity and Steric Effects

Polar Effects and Alternation

Technical Significance of Copolymerization

Block and Graft Copolymers

Techniques of Polymerizations

Bulk Polymerization

Solution Polymerization

Suspension Polymerization

Emulsion Polymerization

## 13. POLYMER CHARACTERISTICS AND POLYMER CHARACTERIZATION

The Structure of Vinyl and Related Polymers

Prevalence of Head-to-Tail Structure in Vinyl Polymers

Branching in Vinyl Polymers

Polymer Degradation  
Thermal Degradation  
Depolymerization  
Substituent Roles  
Mechanochemical Degradation  
Aging or Oxidative Degradation  
Photodegradation  
The Concept of Average Molecular Weight  
Viscosity Average Molecular Weight  
General Expression for Viscosity Average Molecular Weight  
Number Average Molecular Weight  
Membrane Osmometry  
Weight Average Molecular Weight : Light Scattering by  
Polymer Solutions  
Dissymmetry  
End-Group Analysis  
Dye Partition Technique  
Dye Interaction Technique  
The Z Average Molecular Weight  
General Requirement of Extrapolation to infinite Dilution  
Polymer Fractionation and Molecular Weight Distribution  
Gel Permeation Chromatography  
The Molecular Size Parameter  
Molecular Weight Distribution in Vinyl Polymers  
Thermal Analysis  
Other Methods and Techniques of Polymer Characterization

#### 14. PLASTICS: MATERIALS AND PROCESSING TECHNOLOGY

Plastics Materials - Introduction  
Polyethylene  
Low Density Polyethylene (LDPE)  
High Density Polyethylene (HDPE)  
Structure and Properties of Polyethylenes  
Uses and Applications of Polyethylenes  
Chlorosulphonated Polyethylene  
Linear Low Density Polyethylene (LLDPE)  
Polypropylene  
Synthesis of Polypropylene  
Structure and Properties of Polypropylene  
Copolymers of Ethylene  
Polystyrene  
Monomer Synthesis  
Polymerization of Styrene  
Structure and Properties of Polystyrene  
Modification to High Impact Grades  
Styrene-Acrylonitrile (SAN) Copolymers and ABS Resins  
Processing, Uses and Applications of Polystyrene  
Acrylic Plastics: Poly (Methyl Methacrylate)  
Acrylic Fibres  
Poly (Vinyl Acetate)  
Polymers Derived from Poly(Vinyl Acetate)  
Poly(Vinyl Chloride)  
Preparation of Vinyl Chloride

Polymerization of Vinyl Chloride  
Structure and Properties of PVC  
Compounding and Processing of PVC  
Applications of PVC  
Copolymers of Vinyl Chloride  
Polytetrafluoroethylene (PTFE)  
Coumarone-Indene Resins  
Polyacetals and Polyethers (Acetal Resins)  
Polyamides  
Preparation of Poly (Hexamethylene Adipamide): Nylon 66  
Preparation of Nylon 6  
Preparation of Nylon 11 and Nylon 12  
Properties, Uses and Applications of the Nylon Polyamides  
Liquid Crystalline Polymers<sup>3</sup>  
Aromatic Polyamides  
Polyimides  
Polyesters  
Alkyds for Oleoresinous Varnishes  
Polyester Resins for Making Laminates and Composites  
Film- and Fibre-Forming Polyester:  
Poly (Ethylene Terephthalate)  
Polyurethanes  
Polycarbonates  
Epoxy resins  
Cellulose plastics  
Cellulose Nitrate  
Cellulose Acetate  
Cellulose Ethers  
Regenerated Cellulose  
Phenolic Resins  
Chemistry of Resin Formation  
Commercial Production  
Phenolic Moulding Powders  
Phenolic Laminates  
Cast Phenolics  
Miscellaneous Applications of Phenolic Resins  
Amino Resins  
Urea-Formaldehyde Resins  
Melamine-Formaldehyde Resins  
Silicones  
Additives for Plastics  
Fillers  
Plasticizers  
Stabilizers  
Colouring Matters  
Lubricants and Flow Promoters  
Cross-linking Agents  
Other Additives  
Plastics Processing Technology  
Moulding Techniques  
Forming Techniques  
Other Techniques  
Chart of Properties

## 15. DIRECTORY

Raw Material Suppliers for Plastic and Plastic Products  
Manufacturers of Plastic Processing Machinery  
Plastics Processing Machinery and Equipment (Foreign)  
Machinery and Equipment for Plastic Converting  
Extruders and Extrusion Lines  
Injection Moulding Machines  
Presses and Accessories  
Blow-Moulding and Thermoforming Machines  
Machinery for converting Reaction Resins  
(Unsaturated Polyesters, Epoxies)  
Coating Lines  
Other Plastics Converting Machines  
Miscellaneous Plastic Machineries

## About NIIR

**NIIR PROJECT CONSULTANCY SERVICES (NPCS)** is a reliable name in the industrial world for offering integrated technical consultancy services. NPCS is manned by engineers, planners, specialists, financial experts, economic analysts and design specialists with extensive experience in the related industries.

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Our Detailed Project report aims at providing all the critical data required by any entrepreneur vying to venture into Project. While expanding a current business or while venturing into new business, entrepreneurs are often faced with the dilemma of zeroing in on a suitable product/line.

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