Epoxy is a term used to denote both the basic components and the cured end products of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resin are a class of thermoset materials used extensively in structural and specialty composite applications because they offer a unique combination of properties that are unattainable with other thermoset resins.

Epoxies are monomers or prepolymer that further reacts with curing agents to yield high performance thermosetting plastics. They have gained wide acceptance in protecting coatings, electrical and structural applications because of their exceptional combination of properties such as toughness, adhesion, chemical resistance and superior electrical properties. Epoxy resins are characterized by the presence of a three membered cycle ether group commonly referred to as an epoxy group 1,2-epoxide, or oxirane. The most widely used epoxy resins are diglycidyl ethers of bisphenol-A derived from bisphenol-A and epichlorohydrin.

The market of epoxy resins are growing day by day. Today the total business of this product is more than 100 crores. Epoxy resins are used for about 75% of wind blades currently produced worldwide, while polyester resins account for the remaining 25%. A standard 1.5-MW (megawatt) wind turbine has approximately 10 tonnes of epoxy in its blades. Traditionally, the markets for epoxy resins have been driven by demand generated primarily in areas of adhesives, building and civil construction, electrical insulation, printed circuit boards, and protective coatings for consumer durables, amongst others.

The major contents of the book are synthesis and characteristics of epoxy resin, manufacture of epoxy resins, epoxide curing reactions, the dynamic mechanical properties of epoxy resins, physical and chemical properties of epoxy resins, epoxy resin adhesives, epoxy resin coatings, epoxy coating give into water, electrical and electronic applications, analysis of epoxides and epoxy resins and the toxicology of epoxy resins.

It will be a standard reference book for professionals and entrepreneurs. Those who are interested in this field can find the complete information from manufacture to final uses of epoxy resin. This presentation will be very helpful to new entrepreneurs, technocrats, research scholars, libraries and existing units.
Contents

1. Synthesis and Characteristics of Epoxy Resin
   Introduction
   Structure of Epoxides
   Epoxidation of Unsaturated Hydrocarbons
   Catalytic Oxidation of Ethylene and Higher Olefins
   Epoxidation by Peroxy Acids and Their Esters
   Preparation of Peroxy Acids
   In Situ Epoxidation
   The Epoxidation Mechanism
   Unsaturated Materials
   Epoxidation by Inorganic Peroxy Acids
   Epoxidation with Aliphatic and Aromatic Hydrocarbon Hydroperoxides
   Epoxidation with Chromic Acid and Chromyl Compounds
   Biological Epoxidation
   Dehydrohalogenation of Substituted Hydroxyl Compounds
   The Epoxidation Mechanism
   Halohydrin Formation
   Epoxides from Epichlorohydrin
   Glycidyl Ethers
   Glycidyl Esters
   Nitrogen-Containing Epoxides
   Thioglycidyl Epoxides
   Silicon-Containing Epoxides
   Organophosphorus Epoxides
   Halogen-Containing Epoxides
   Epoxides from Hydroxy Sulfonates or Halogenated Acetates
   Epoxides from Glycols
   Epoxidation by Condensation
   Darzens Glycidic Ester Condensations
   Epoxides from Ylids
   Epoxides from Halogenated Ketones and Nickel Carbonyl
   Epoxides from the Reaction of Diazomethane with Aldehydes or Ketones
   Epoxides Containing Unsaturation
   Conclusions

2. Manufacture of Epoxy Resins
   Raw Materials
   Manufacture
   Plant Location
   Machinery Needed
   Profit

3. Epoxide-Curing Reactions
   The Effect of Epoxide Structure on Reactivity with Curing Agents
   The Mechanism of the Curing Reaction
   Polyaddition Reactions
   Polyamines
   Polyamides
   Polyureas
   Polyurethanes
Polyisocyanates
Polymercaptans
Polyhydric Alcohols
Polyphenols
Polycarboxylic Acids
Polybasic Acid Anhydrides
Silanes and Silanols
Others
Polymerization
Anionic Catalysts
Cationic Catalysts

4. The Dynamic Mechanical Properties of Epoxy Resins
   Basic Parameters
   The Glassy Transition and Dynamic Mechanical Dispersion
   Temperature and Frequency Interdependence
   Experimental
   Results and Discussion
   Standard Measurements
   Dynamic Measurements
   Comparison of Results
   Treatment by Reduced Variables
   Conclusions

5. Physical and Chemical Properties of Epoxy Resins
   Solubility and Surface Properties
   Network Structure and Physical Properties
   Aging and Chemorheology
   Bisphenol a Epoxy Homopolymers and Copolymers
   Thermal Transition Effects
   Dynamic Mechanical Response
   Relaxation and Fracture Properties
   Properties Compared with Elastomers and Thermoplastics

6. Epoxy Resin Adhesives
   Introduction
   Theories of Adhesion and Ahesive-joint Strength
   Wetting and Spreading Phenomena
   Boundary-Layer Theory
   Surface-Attachment Theory of Adhesive-Joint Strengths
   Stress Distribution in Adhesive Joints
   Rheological Aspects of Adhesives
   Unified Interpretation of Adhesive-Joint Strengths
   Physical and Mechanical Aspects of Epoxy-Resin Adhesives
   Dynamic Mechanical Techniques
   Mechanical Behavior of Epoxy Adhesives During Joint Formation
   Strength of Adhesive Materials
   Chemical Aspects of Epoxy-based Adhesives
   Curing Agents for Bisphenol A Epoxy Adhesives
   Modifiers for Bisphenol A Epoxy Adhesives
   Adhesives Based on Other Epoxy Materials
   Technological Properties of Epoxy-adhesive Systems
   Cure and Thermal Softening Behavior of Epoxy Adhesives
Stress and Environmental Durability of Adhesive Joints
Applications of Epoxy Adhesives
Future Prospects

7. Epoxy Resin Coatings
Classification of Epoxy-Resin Coatings
Epoxy Resins Commonly Used in Coatings
Epoxy-Resin Esters
Esters Produced from Solid Epoxy Resins
General Remarks
Formulation Latitude
Esters Produced from Liquid Epoxy Resins
Precatalyzed Liquid Epoxy Resin for the Production of Solid Epoxy Resins and Epoxy-Resin Esters
Cooking Procedure
“Two-Step” Liquid-Epoxy-Resin Route to Epoxy-Resin Esters
Cooking Procedure
Solid-Epoxy-Resin Solution Coatings
Cold-Cured Epoxy-Resin Systems
Polyamine Curing Agents
Polyamine-Adduct Curing Agents
Polyamide-Resin Curing Agents
Polyamide-Adduct Curing Agents
Tertiary Amine Curing Agents
Industrial Maintenance Coatings Based on Cold-Cured Epoxy-Resin Systems
High-Film-Build Cold-Cured Epoxy-Resin Coatings
Application Instructions
 Manufacturing Instructions
Epoxy Baking Finishes
Epoxy-Phenolic Coating Systems
Epoxy-Urea-Formaldehyde Resin Coating Systems
Epoxy-Thermosetting Acrylic Coating Systems
Liquid Epoxy Resins in Solventless and Super-High-Solids Systems
Special Application Equipment and Formulation for Solventless Systems
Manufacturing Instructions
Application
Ketimine Curing Agents
Manufacturing Instructions
Application
Curing Characteristics
Powder Coatings
Application Equipment
Epoxy-Resin Powder-Coating Formulations
Fusion-Produced Epoxy-Resin Powders
Manufacturing Instructions
Applications Instructions
Dry-blended Epoxy-Resin Powders
Manufacturing Instructions
Application Instructions
Properties and Applications
Thermoplastic Epoxy Resins
Zinc-Rich and General Purpose Shop Primers
Manufacturing Instructions
Application Instructions
8. Epoxy Coating Give into Water

9. Electrical and Electronic Applications : Sealants and Foams
   Electronic and Electrical Applications
   Introduction
   Casting
   Potting
   Encapsulation
   Coatings
   Sealing
   Molding
   Formulation of the Resin System
   Internal Stresses
   Rapid Cures
   Flexibilizing Epoxy Resins
   Fillers
   Reactive Diluents
   Cycloaliphatic Epoxides
   High-Temperature Epoxy-Resin Systems
   Flame-Retardant Epoxy Resins
   Colorless Epoxy Resins
   Epoxy Formulations
   Molding
   Molding Compounds
   Molding Technology
   Liquid-Injection Molding
   Pellets and Preforms
   Epoxy Sealants
   Epoxy Foams
   Gas-Blown Foams
   Syntactic Foams
   One-Package Foams
   Epoxy-Foam Applications
   Epoxy Strippers
   Handling of Epoxy Casting Systems

10. Analysis of Epoxides and Epoxy Resins
Uncured Epoxy Resins
Qualitative Tests
Detection of Free Epoxy Groups
Determination of Epoxy Group—Lithium-Chloride Test
Reagents
Procedure
Determination of Epoxy Group—Periodic Acid Test
Reagents
Procedure
Determination of Epoxy Group—Pyrolysis Test
Reagents
Procedure
Determination of Epoxy Group—Lepidine Test
Reagents
Procedure
Detection of the Bisphenol A Skeleton
Determination of Bisphenol A Epoxy Resins—Mercuric Oxide and Nitric Acid Tests
Reagents
Procedure
Determination of Bisphenol A Epoxy Resins in Coatings—Nitric Acid Test Reagents
Reagent
Procedure
Determination of Bisphenol A Epoxy Resins—Filter-Paper Test
Reagents
Procedure
Determination of Bisphenol A Epoxy Resin—Formaldehyde Test
Reagents
Procedure
Determination of Bisphenol A Epoxy Resins—Phenylenediamine Test
Reagent
Procedure
Detection of Epoxy Resins Based on 4,4'-Diamino-diphenylmethane
Determination of Epoxy Resins Based on 4,4'-Diaminodiphenylmethane
Reagents
Procedure
Detection of Other Epoxy Resins
Quantitative Tests of the Epoxy Group
Hydrohalogenation Methods
Estimation of Epoxy Group—Hydrochloric Acid in Dioxane, Methyl Ethyl Ketone, or Dimethylformamide
Reagents
Procedure
Calculations
Estimation of the Epoxy Group—Pyridinium Chloride in Pyridine
Reagents
Procedure
Hydrohalogenation by Direct Titration
Estimation of Epoxy Group
Reagents
Procedure
Calculations
Other Chemical Methods
Estimation of Other Functional Groups
Hydroxyl Group
1. **α-Glycol Group**

   Estimation of α-Glycol Group

   **Reagents**

   **Procedure**

   **Calculation**

   **Chlorine**

   Esterification Equivalent Weight

   Estimation of Esterification Equivalent Weight

   **Reagents**

   **Procedure**

   **Calculation**

   Infrared Spectroscopy

   **Technique**

   Epoxide Absorption Bands

   Epoxy Resins

   Quantitative Estimation

   Following the Degree of Cure

   Other Physical Methods

   Ultraviolet Spectroscopy

   Electron Spin and Nuclear Magnetic Resonance Methods

   Gas Chromatography

   Paper Chromatography

   Thin-Layer and Gel-Permeation Chromatography

   Handling Properties

   Molecular Weight

   Softening Point

   Viscosity

   Color

   Blends and Compounds

   Hardeners and Accelerators

   Organic Acid Anhydrides

   Determination of Acid and Anhydride Content

   **Reagents**

   **Procedure**

   **Calculations**

   **Amines**

   Determination of Amine Number

   **Reagents**

   **Procedure**

   **Calculation**

   The Curing Process

   Curing Characteristics of Epoxy Resin-Hardener Systems

   Determining the Degree of Cure

   Analysis of Cured Epoxy Resins

11. **The Toxicology of Epoxy Resins**

   **Introduction**

   **Experimental Method**

   **Materials**

   Acute Toxicity

   Chronic Toxicity

   Irritation

   Sensitization
Results
Acute Toxicity
Chronic Toxicity
Irritation
Sensitization
Medical Experience with Epoxy Resins
Comment

12. Photographs of Machinery with Suppliers
Contact Details

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.


NPCS also publishes varies process technology, technical, reference, self employment and startup books, directory, business and industry database, bankable detailed project report, market research report on various industries, small scale industry and profit making business. Besides being used by manufacturers, industrialists and entrepreneurs, our publications are also used by professionals including project engineers, information services bureau, consultants and project consultancy firms as one of the input in their research.

NIIR PROJECT CONSULTANCY SERVICES, 106-E, Kamla Nagar, New Delhi-110007, India. Email: npcs.india@gmail.com Website: NiIR.org

Mon, 30 Dec 2019 07:55:02 +0530