Characterization of Polymers Using TGA

W.J. Sichina, Marketing Manager

Introduction

Thermogravimetric analysis (TGA) is one of the members of the family of thermal analysis techniques used to characterize a wide variety of materials. TGA provides complimentary and supplementary characterization information to the most commonly used thermal technique, DSC.

TGA measures the amount and rate (velocity) of change in the mass of a sample as a function of temperature or time in a controlled atmosphere. The measurements are used primarily to determine the thermal and/or oxidative stabilities of materials as well as their compositional properties. The technique can analyze materials that exhibit either mass loss or gain due to decomposition, oxidation or loss of volatiles (such as moisture). It is especially useful for the study of polymeric materials, including thermoplastics, thermosets, elastomers, composites, films, fibers, coatings and paints.

TGA measurements provide valuable information that can be used to select materials for certain end-use applications, predict product performance and improve product quality. The technique is particularly useful for the following types of measurements:

- Compositional analysis of multi-component materials or blends
- Thermal stabilities
- Oxidative stabilities
- Estimation of product lifetimes
- Decomposition kinetics
- Effects of reactive atmospheres on materials
- Filler content of materials
- Moisture and volatiles content

PerkinElmer offers a variety of high performance TGA instruments encompassing a wide range of application needs and operational requirements. All of the TGA instruments feature an optional, state-of-the-art autosampler for reliable, unattended operation.

The extended capabilities of the PerkinElmer TGA, as a valuable tool for polymeric characterization and quality assurance are demonstrated by these applications.

Thermal Stabilities and Moisture Content

Figure 1 shows the TGA results generated on nylon 6,6 toothbrush bristles. The plot shows the percent mass as a function of sample temperature for the nylon 6,6 bristles under a nitrogen purge. Approximately 10 mg of sample was heated at a rate of 20 C/min with the PerkinElmer TGA.

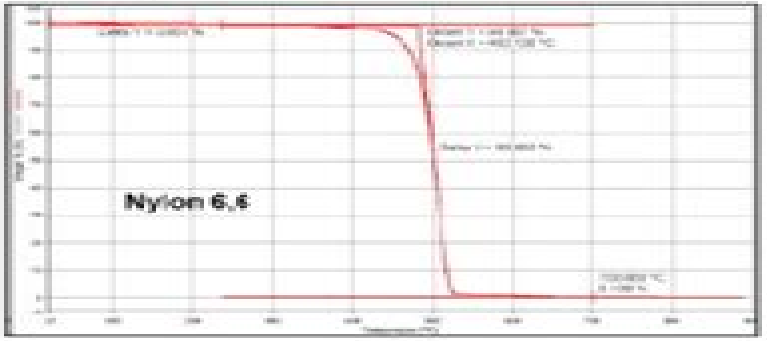

Figure 1. TGA results obtained for nylon 6,6 bristles showing thermal degradation

PerkinElmer™ instruments

Characterization Analysis Of Polymers

Santanu Chattopadhyay,Nikhil Kumar

Characterization Analysis Of Polymers:

Polymer Characterization Dan Campbell,2017-12-21 Discerning the properties of polymers and polymer based materials requires a good understanding of characterization This revised and updated text provides a comprehensive survey of characterization methods within its simple concise chapters Polymer Characterization Physical Techniques provides an overview of a wide variety of characterization methods which makes it an excellent textbook and reference It starts with a description of basic polymer science providing a solid foundation from which to understand the key physical characterization techniques The authors explain physical principles without heavy theory and give special emphasis to the application of the techniques to polymers with plenty of illustrations Topics covered include molecular weight determination molecular and structural characterization by spectroscopic techniques morphology and structural characterization by microscopy and diffraction and thermal analysis This edition contains a new chapter on surface analysis as well as some revised problems and solutions The concise treatment of each topic offers even those with little prior knowledge of the subject an accessible source to relevant simple descriptions in a well organized format *Polymer Characterization* Nicholas P. Cheremisinoff,1996-12-31 This volume provides an overview of polymer characterization test methods The methods and instrumentation described represent modern analytical techniques useful to researchers product development specialists and quality control experts in polymer synthesis and manufacturing Engineers polymer scientists and technicians will find this volume useful in selecting approaches and techniques applicable to characterizing molecular compositional rheological and thermodynamic properties of elastomers and plastics Characterization and Analysis of Polymers Wiley,2008-02-08 Based on Wiley s renowned Encyclopedia of Polymer Science and Technology this book provides coverage of key methods of characterization of the physical and chemical properties of polymers including atomic force microscopy chromatographic methods laser light scattering nuclear magnetic resonance and thermal analysis among others Written by prominent scholars from around the world this reference presents over twenty five self contained articles on the most used analytical techniques currently practiced in polymer science **Molecular Characterization and Analysis of Polymers** John M. Chalmers,Robert J. Meier,2008-12-09 Written by expert contributors from the academic and industrial sectors this book presents traditional and modern approaches to polymer characterization and analysis The emphasis is on pragmatics problem solving and property determination real world applications provide a context for key concepts The characterizations focus on organic polymer and polymer product microstructure and composition Approaches molecular characterization and analysis of polymers from the viewpoint of problem solving and polymer property characterization rather than from a technique championing approach Focuses on providing a means to ascertaining the optimum approach or technique s to solve a problem measure a property and thereby develop an analytical competence in the molecular characterization and analysis of real world polymer products Provides background on polymer chemistry and microstructure discussions of

polymer chain morphology degradation and product failure and additive analysis and considers the supporting roles of modeling and high throughput analysis **Polymers: Polymer Characterization and Analysis** Jacqueline I. Kroschwitz,1990-01-29 This volume is one of a series of selected reprints from the world renowned Encyclopedia of Polymer Science and Engineering designed to provide specific audiences with articles grouped by a central theme Included are all of the original articles related to polymer characterization and analysis with full texts tables figures and reference materials from the original reproduced unchanged Articles are by industrial or academic experts in their field Includes coverage of the newest analytical methods a wealth of physical and mechanical data and standards and specifications for materials Alphabetical organization extensive cross references and a complete index further enhance its usefulness *Polymer Characterization* Donald Campbell,Richard Arthur Pethrick,J. R. White, Discerning the properties of polymers and polymer based materials requires a good understanding of characterization This revised and updated text provides a comprehensive survey of characterization methods within its simple concise chapters Polymer Characterization Physical Techniques provides an overview of a wide variety of characterization methods which makes it an excellent textbook and reference It starts with a description of basic polymer science providing a solid foundation from which to understand the key physical characterization techniques The authors explain physical principles without heavy theory and give special emphasis to the application of the techniques to polymers with plenty of illustrations Topics covered include molecular weight determination molecular and structural characterization by spectroscopic techniques morphology and structural characterization by microscopy and diffraction and thermal analysis This edition contains a new chapter on surface analysis as well as some revised problems and solutions The concise treatment of each topic offers even those with little prior knowledge of the subject an accessible source to relevant simple descriptions in a well organized format **Polymer Surface Characterization** Luigia Sabbatini,2014-07-28 Polymer Surface Characterization provides a comprehensive approach to the surface analysis of polymers of technological interest by means of modern analytical techniques Basic principles operative conditions applications performance and limiting features are supplied together with current advances in instrumental apparatus Each chapter is devoted to one technique and is self consistent the end of chapter references would allow the reader a quick access to more detailed information After an introductory chapter techniques that can interrogate the very shallow depth of a polymer surface spanning from the top few angstroms in secondary ions mass spectrometry to 2 10 nm in X ray photoelectron spectroscopy are discussed followed by Fourier transform infrared spectroscopy and chapters on characterization by scanning probe microscopy electron microscopies wettability and spectroscopic ellipsometry

Thermal Analysis of Polymers Joseph D. Menczel,R. Bruce Prime,2009-04-20 Presents a solid introduction to thermal analysis methods instrumentation calibration and application along with the necessary theoretical background Useful to chemists physicists materials scientists and engineers who are new to thermal analysis techniques and to existing users of

thermal analysis who wish expand their experience to new techniques and applications Topics covered include Differential Scanning Calorimetry and Differential Thermal Analysis DSC DTA Thermogravimetry Thermomechanical Analysis and Dilatometry Dynamic Mechanical Analysis Micro Thermal Analysis Hot Stage Microscopy and Instrumentation Written by experts in the various areas of thermal analysis Relevant and detailed experiments and examples follow each chapter

Modern Methods of Polymer Characterization Howard G. Barth,Jimmy W. Mays,1991-09-03 Presents the methods used for characterization of polymers In addition to theory and basic principles the instrumentation and apparatus necessary for methods used to study the kinetic and thermodynamic interactions of a polymer with its environment are covered in detail Some of the methods examined include polymer separations and characterization by size exclusion and high performance chromatography inverse gas chromatography osmometry viscometry ultracentrifugation light scattering and spectroscopy

Thermal Characterization of Polymeric Materials Edith Turi,2012-12-02 Thermal Characterization of Polymeric Materials is a critical review and a concise evaluation of the application of thermal analysis in polymer science and engineering This book is divided into nine chapters that specifically tackle the instrumentation theory and a wide variety of applications of thermal characterization The introductory chapters provide an overview of all aspects of thermal analytical methods and apparatus and the theory underlying the basic principles of thermal analysis These chapters also examine the theories and functions of state for thermometry dilatometry thermomechanical analysis calorimetry thermogravimetry These topics are followed by a discussion on single component and multicomponent systems and their phase transitions as influenced by concentration pressure deformation molecular weight and copolymerization The subsequent chapters explore the influence of important chemical and physical parameters on the glass transition crystallization and melting of thermoplastic materials The discussion then shifts to the theoretical aspects of polymer polymer compatibility phase separation and miscibility in mixed polymer systems This book further considers the thermal analysis in thermosets elastomers and fibers The concluding chapters present the methods of obtaining information on the relative flammability properties of polymers for screening fire retardant additives and for studying the mechanism of flame inhibition These chapters also look into the thermal analysis of antioxidants stabilizers lubricants plasticizers impact modifiers and fire retardants Polymer scientists and researchers will find this book invaluable **Polymer Characterization by Thermal Methods of Analysis** Jen Chiu,1974 1st published in Journal of Macromolecular Science Chemistry V A8 no 1 1974 **Polymer Characterization by Thermal Methods of Analysis** Jen Chiu,1974 **Polymer Characterization Interdisciplinary Approaches** Clara D. Craver,2012-12-06 Physical and spectroscopic methods have been used jointly for characterization of polymers for at least four decades Yet new techniques permit increasingly refined determination of polymer chemistry and morphol ogy_ The correlation of this knowledge with physical properties of polymers is helpful to planned synthesis of new products The most prominent spectroscopic techniques through the forties and fifties were infrared and ultraviolet spectroscopy Nuclear magnetic

resonance electron spin resonance and MOssbauer spectroscopy started making sig nificant contributions to polymer chemistry in the early sixties Still more recently fluorescence spectroscopy and laser Raman spectroscopy have become readily appli cable to polymers and are contributing significantly to the understanding of the relationship between polymer structure and properties Determination of the distribution of monomer se quences by molecular size has become possible through combined gel permeation chromatography and spectroscopic analysis Fragments of polymers from chemical break down or from pyrolysis are further fractionated and structurally analyzed The relationship between the chemistry of polymers and performance can be determined from changes in chemical structure and orientation after curing degradation or physical or thermal manipulation of the polymers **Polymer Characterization** Santanu Chattopadhyay,Nikhil Kumar,2025-12-16 This book provides a comprehensive and practical guide to the characterization techniques for understanding the structure properties and processing of polymers elastomers and composites It serves as an invaluable resource for students researchers and professionals in the fields of materials science polymer chemistry chemical engineering and related disciplines The main features of this book are 1 Integration of Theory and Practice It bridges the gap between theoretical principles and practical applications of polymer characterization techniques Each chapter covers the fundamental principles behind the techniques and provides insights into their real world applications and relevance in research development and quality control 2 Comprehensive Coverage The book covers a wide range of characterization techniques including spectroscopic methods UV Vis Infrared NMR thermal analysis techniques surface analysis techniques XPS SIMS and microscopy techniques optical AFM electron microscopy This comprehensive coverage provides readers with a complete understanding of the various tools for polymer characterization 3 Emphasis on Structure Property Relationships Understanding the relationship between polymer structure properties and processing is crucial for optimizing material performance and designing new materials with tailored properties This book highlights how different characterization techniques can elucidate these relationships enabling readers to make informed decisions in material engineering 4 Practical Applications Includes numerous real life examples and case studies illustrating the practical applications of polymer characterization techniques in various industries such as automotive aerospace electronics health care and packaging

Analytical Methods for Polymer Characterization Rui Yang,2018-01-09 Analytical Methods for Polymer Characterization presents a collection of methods for polymer analysis Topics include chromatographic methods gas chromatography inverse gas chromatography and pyrolysis gas chromatography mass spectrometry spectroscopic methods ultraviolet visible spectroscopy infrared spectroscopy Raman spectroscopy and nuclear magnetic resonance thermal analysis differential scanning calorimetry and thermogravimetry microscopy methods scanning electron microscopy transmission electron microscopy and atomic force microscopy and x ray diffraction The author also discusses mechanical and dynamic mechanical properties **Characterisation of Polymers by Thermal Analysis** W.M. Groenewoud,2001-05-21 Thermal

Analysis TA has become an indispensable family of analytical techniques in the polymer research The increased importance of these techniques can be seen as the result of three more or less parallel developments a tempestuous development of TA measuring techniques in combination with a high degree of automation the strongly increased understanding of the underlaying theory and the increasing knowledge of the relation between the polymers chemical structure and their physical properties These areas are still in their developmental stages especially the third area The increasing knowledge of the dependence of physical properties on chemical structure just accentuated more and more the need for accurate thermoanalytical measurements and this knowledge is very important for the first stages of the development of new polymeric systems Besides the contribution of TA remains necessary for the technical and commercial development of such a new polymer system The use of the various TA techniques in these processes is described in this book in nine chapters while chapter ten illustrates the information obtained about different polymers during special case studies This book illustrates in this way applications of a wide variety of TA techniques whilst it is written from a materials characterisation rather than from a TA point of view with attention being paid to the chemical structure physical properties correlations **Surface Characterization of Advanced Polymers** Luigia Sabbatini,Pier Giorgio Zambonin,1993-07 Surface Characterization of Advanced Polymers Edited by Luigia Sabbatini and Pier Giorgio Zambonin This book provides a comprehensive approach to the surface analysis of polymers of technological interest by means of modern electron and ion spectroscopies XPS ToF SIMS ISS HREELS Case studies are critically discussed by well known experts who propose strategies for the unequivocal interpretation of surface spectroscopic findings Newcomers to the field will benefit from the extensive introductory chapter describing the fundamentals of spectroscopic techniques This is a specialized book written at an easily comprehensible level It is recommended to all people involved in surface characterization and chemical analysis and more generally interested in polymer science and advanced materials Professors at the University of Bari Italy Luigia Sabbatini and Pier Giorgio Zambonin have published extensively in the field Their research interests include electrosynthesis spectroscopic characterization and applications of conducting and semiconducting polymers **Polymer Analysis and Characterization** ,1990 *Polymer Characterization* Donald Campbell,J. R. White,1989 This undergraduate text provides an introduction to the physical principles behind the various techniques of polymer characterization without becoming deeply theoretical It contains much detail of a practical nature and special emphasis is placed on applications Paper edition unseen 36 Annotation c 2003 Book News Inc Portland OR booknews com *Characterization and Analysis of Polymers by Gas Chromatography* Malcolm P. Stevens,1969 Written primarily to help the polymer chemist in streamlining his analytical techniques

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