

# **Failure of Plastics and Rubber Products**

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**Causes, Effects and Case Studies  
Involving Degradation**

**by**

**David Wright**

# Failure Of Plastics And Rubber Products Causes Effects And Case Studies Involving Degradation

**IM Harris**



## **Failure Of Plastics And Rubber Products Causes Effects And Case Studies Involving Degradation:**

**Failure of Plastics and Rubber Products** D. Wright, 2001-06 Plastics and rubbers together make up the most adaptable and varied class of materials available to product designers They may be transparent or opaque rigid or flexible lightweight insulating and weatherproof They are used in almost every industry and in every part of the home Applications range from the humble hot water bottle to the sheathing on a high voltage cable and from a simple scrubbing brush to a tank for storing hydrochloric acid Products may be disposable e g packaging goods or intended to last for decades such as a buried sewage pipe However it is this very diversity which makes materials selection so difficult and appropriate design so important Indeed the one thing that all these particular products have in common is their presence in this book of failures Failures due to degradation may result from exposure to the weather or an aggressive operating environment Alternatively they may be caused by the introduction of an external agent unforeseen by the product designer They may be rapid or very slow and they may result from a combination of factors In this book Dr Wright describes the following mechanisms of polymer degradation and then illustrates each failure mechanism with a number of case studies Thermo oxidation Photo oxidation Degradation due to ionising radiation Chemical attack Environmental stress cracking Other miscellaneous effects including treeing electrochemical degradation and biodegradation Many of the case studies are based on Dr Wrights own experiences whilst working at Rapra In each case he describes the circumstances of the failure and discusses both the consequences of the failure and the lessons that may be learned from it Most of the failed products are familiar to us all and his style is both readable and informative Photographs are included where available The book will be essential reading for designers engineers product specifiers and forensic engineers Materials suppliers and processors will also benefit from the pragmatic analysis and advice it contains It will also be of value to all students of polymer science and technology providing an essential insight into the practical application of plastics and rubbers and the potential problems Finally it will be of interest to a much broader readership including anyone who ever wondered why things break and it should become a standard reference work in all technical libraries This book was written with the support of the UK Department of Trade and Industry It is intended to raise awareness of the causes and consequences of polymer product failures in order to reduce the future incidences of such failures and their considerable costs to industry

**Forensic Polymer Engineering** Peter Rhys Lewis, 2016-06-09 Forensic Polymer Engineering Why Polymer Products Fail in Service Second Edition presents and explains the latest forensic engineering techniques used in the investigation of failed polymer materials that are illustrated with a very large number of detailed case studies which show the different types of failure and the forensic engineering techniques used in their investigation In this updated edition new case studies have been added to include patent disputes and failed products such as spiral wound wall storage tanks lithium battery explosions water bottle failures and breast implant failures such as the PIP scandal New images demonstrating failure have been included and images from the previous edition are reproduced

in color and enhanced with additional explanatory detail With a dedicated focus on polymeric materials the book includes details on the experimental techniques that are used to characterize the materials particularly in cases of failure Finally the book has information on the fabrication of polymer devices as manufacturing flaws often play a role in failure Demonstrates the latest forensic engineering techniques used in the investigation of failed polymer components Presents detailed case studies that illustrate different types of failure in polymer components fittings and medical devices Examines the role of manufacturing in product failure with an overview of faults recognized in methods design and material selection Provides an integrated approach to polymer failures that covers everything from basic materials properties through to the experimental techniques required to study them

**Wood-Plastic Composites** Anatole A. Klyosov, 2007-08-31 A comprehensive practical guide to wood plastic composites and their properties This is the first book that presents an overview of the main principles underlying the composition of wood plastic composite WPC materials and their performance in the real world Focusing on the characteristics of WPC materials rather than their manufacture this guide bridges the gap between laboratory based research and testing and the properties WPC materials exhibit when they re used in decks railing systems fences and other common applications Complete with practical examples and case studies this guide Describes compositions of WPC materials including thermoplastics cellulose fiber minerals additives and their properties Covers mechanical properties microbial resistance water absorption flammability slip resistance thermal expansion contraction sensitivity to oxidation and solar radiation and rheological properties of hot melts of WPC Covers subjects that determine esthetics properties performance and durability of wood plastic composite products Includes comparisons of different ASTM methods and procedures that apply to specific properties This is a comprehensive hands on reference for scientists engineers and researchers working with wood plastic composites in plastics and polymers materials science microbiology rheology plastic technology and chemical engineering as well as an outstanding text for graduate students in these disciplines It s also an excellent resource for suppliers and WPC manufacturers and an accessible guide for developers homebuilders and landscape architects who want to know more about wood plastic composites and their performance in the real world

**Weathering of Polymers and Plastic Materials** Luís Eduardo Pimentel Real, 2023-09-12 This book presents the state of the art on the weathering of polymers and plastic materials in outdoor applications comprising natural weathering accelerated climatic weathering laboratory artificial accelerated weathering and lifetime prediction methodology It summarizes the most suitable methods of instrumental analysis to access and quantify when possible degradation caused by weathering while also covering the degradation and stabilization of polymers based on environmental and artificially induced factors Innovative polymer additives and some developments in polymeric materials designed for outdoor applications are also included emphasizing a few selected cases the book intends to be an important reference source for those involved in the study of the durability of polymers and plastics production of plastics for exterior applications chemists responsible for quality control of plastic

products and researchers and students across plastics engineering polymer science polymer chemistry and environmental science

**Failure of Polymer Products Due to Photo-oxidation** , *Forensic Engineering* Colin R. Gagg, 2020-02-21

*Forensic Engineering The Art and Craft of a Failure Detective* synthesizes the current academic knowledge with advances in process and techniques developed in the last several years to bring forensic materials and engineering analysis into the 21st century The techniques covered in the book are applied to the myriad types of cases the forensic engineer and investigator may face serving as a working manual for practitioners Analytical techniques and practical applied engineering principles are illustrated in such cases as patent and intellectual property disputes building and product failures faulty design air and rail disasters automobile recalls and civil and criminal cases Both private and criminal cases are covered as well as the legal obligation requirements and responsibilities under the law particularly in cases of serious injury or even death Forensic Engineering will appeal to professionals working in failure analysis loss adjustment occupational health and safety as well as professionals working in a legal capacity in cases of product failure and liability including criminal cases fraud investigation and private consultants in engineering and forensic engineering

**Failure of Polymer Products Due to Thermo-oxidation** D. C. Wright, 2001 The combined effects of oxidising media and heat result in degradation by thermo oxidation The principles and cases described in this review emphasise long term degradation in service Two additional phenomena that influence thermo oxidation are also described catalysis by certain metal ions and the influence of stress An additional indexed section containing several hundred abstracts from the Polymer Library gives useful references for further reading

**Failure Analysis** Marius Bazu, Titu Bajenescu, 2011-03-08 Failure analysis is the preferred method to investigate product or process reliability and to ensure optimum performance of electrical components and systems The physics of failure approach is the only internationally accepted solution for continuously improving the reliability of materials devices and processes The models have been developed from the physical and chemical phenomena that are responsible for degradation or failure of electronic components and materials and now replace popular distribution models for failure mechanisms such as Weibull or lognormal Reliability engineers need practical orientation around the complex procedures involved in failure analysis This guide acts as a tool for all advanced techniques their benefits and vital aspects of their use in a reliability programme Using twelve complex case studies the authors explain why failure analysis should be used with electronic components when implementation is appropriate and methods for its successful use Inside you will find detailed coverage on a synergistic approach to failure modes and mechanisms along with reliability physics and the failure analysis of materials emphasizing the vital importance of cooperation between a product development team involved the reasons why failure analysis is an important tool for improving yield and reliability by corrective actions the design stage highlighting the concurrent engineering approach and DfR Design for Reliability failure analysis during fabrication covering reliability monitoring process monitors and package reliability reliability testing after fabrication including reliability assessment at this stage and

corrective actions a large variety of methods such as electrical methods thermal methods optical methods electron microscopy mechanical methods X Ray methods spectroscopic acoustical and laser methods new challenges in reliability testing such as its use in microsystems and nanostructures This practical yet comprehensive reference is useful for manufacturers and engineers involved in the design fabrication and testing of electronic components devices ICs and electronic systems as well as for users of components in complex systems wanting to discover the roots of the reliability flaws for their products

**Failure of Polymer Products Due to Chemical Attack** David C. Wright, 2001 Degradation reactions grouped under the heading chemical attack include oxidation hydrolysis halogenation and other reactions They also include some purely physical interactions between materials and fluids dominated by the absorption of fluid into the material or vice versa One particular mechanism described in some detail is acid induced stress corrosion cracking which is the most frequent cause of premature failure of GRP products and where the principle degradation reaction is between the fluid and the glass fibres An additional indexed section containing several hundred abstracts from the Rapra Polymer Library database gives useful references for further reading

**Legionella Contamination in Water Environment** Silvia Bonetta, Sara Bonetta, 2021-09-01 Legionella spp are ubiquitous microorganisms that are widely distributed in aquatic environments Water systems of large buildings such as hospitals hotels and rental units are often contaminated by legionellae and various parameters such as physical chemical and microbial building water system characteristics can influence Legionella occurrence A range of physical and chemical disinfection methods have been proposed to control Legionella contamination however to date the most effective procedures have not been defined There is a need to survey legionellae in water systems to prevent legionellosis Although the assessment of L pneumophila in water is typically performed by culture isolation on selective media it has several limits For this reason alternative tools for rapid sensitive and specific detection of Legionella in water samples have been proposed In order to increase knowledge on different aspects of Legionella contamination in the water environment this book gathers research studies related to the occurrence of Legionella in water systems of different environments the role of different factors that can influence the Legionella contamination as well as the advantages and disadvantages of different methodological approaches

**Practical Guide to the Assessment of the Useful Life of Plastics** R. Brown, John H. Greenwood, 2002 After price and delivery time the most frequently asked question about a product is How long will it last Lifetime expectancy is often many years the service conditions may be complex and there is a scarcity of definitive data on durability The situation is complicated by the fact that there are a vast number of degradation agents service conditions properties of importance and different plastics There are many inherent difficulties in designing durability tests In many cases the time scale involved is such that accelerated test conditions are essential Whilst large amounts of durability data are generated by accelerated methods much of it is only useful for quality control purposes and relatively little has been validated as being realistically capable of representing service Most assessments of the lifetime of plastics are

made by considering some measure of performance such as impact strength and specifying some lower limit for the property which is taken as the end point Lifetime is not necessarily measured in time For example for some products it will be thought of as the number of cycles of use The object of this publication is to provide practical guidance on assessing the useful service life of plastics It describes test procedures and extrapolation techniques together with the inherent limitations and problems The Guide aims to make available the wealth of information that can be applied to help maximise the effectiveness of a durability testing programme This guide seeks to be comprehensive but concentrates on the most common environmental effects causing degradation The test procedures used are outlined and the relevant textbooks and international standards are well referenced Examples of lifetime testing studies are cited The Practical Guide will be useful for anyone responsible for designing manufacturing or testing plastic components It will also be of benefit to suppliers and users of end products as assessment of useful lifetime is critical to the economics and safety aspects of any component Key features Test methods outlined Accelerated testing discussed Prediction methods described Standards cited Key sources of information listed

Handbook of Troubleshooting Plastics Processes John R. Wagner, Jr., 2012-09-19 This handbook provides a framework for understanding how to characterize plastic manufacturing processes for use in troubleshooting problems The 21 chapters are authored by well known and experienced engineers who have specialized knowledge about the processes covered in this practical guide From the Preface In every chapter the process is described and the most common problems are discussed along with the root causes and potential technical solutions Numerous case studies are provided that illustrate the troubleshooting process Mark A Spalding The Dow Chemical Company

**Polypropylene** Fatih Dogan (Associate professor), Weiyu Wang, Yiming Zeng, 2020 Polypropylene PP is one of the most important thermoplastics widely applied in the fields of automobile packaging clothing and plastic molding Since J Paul Hogan and Robert L Banks accidentally synthesized crystalline PP in 1951 tremendous breakthroughs have been achieved and have successfully transferred PP from a discovery in the laboratory to an indispensable commodity Along with the commercial success progress in the academic community of PP has expanded our toolbox to tailor tactility and microstructure improve thermal and mechanical properties understand and control crystallization behavior develop efficient functionalization strategies and explore novel applications This book provides an overview of progress in PP from the perspectives of synthesis structure property relationship processing PP composites and applications

**Plastics Engineering** R. J Crawford, P. J. Martin, 2020-01-24 Plastics Engineering Fourth Edition presents basic essentials on the properties and processing behaviour of plastics and composites The book gives engineers and technologists a sound understanding of basic principles without the introduction of unduly complex levels of mathematics or chemistry Early chapters discuss the types of plastics currently available and describe how designers select a plastic for a particular application Later chapters guide the reader through the mechanical behaviour of materials along with a detailed analysis of their major processing techniques and principles All

techniques are illustrated with numerous worked examples within each chapter with further problems provided at the end. This updated edition has been thoroughly revised to reflect major changes in plastic materials and their processing techniques that have occurred since the previous edition. The plastics and processing techniques addressed within the book have been comprehensively updated to reflect current materials and technologies with new worked examples and problems also included.

Care and Repair of Advanced Composites Keith B Armstrong, William Cole, Eric Chesmar, Francois Museux, 2020-12-31. The new edition of the well known Care and Repair of Advanced Composites 3rd Edition improves on the usefulness of this practical guide geared towards the aerospace industry. Keith B Armstrong the original lead author of the first edition was still in charge of this project counting on the expert support of Eric Chesmar senior composites specialist at United Airlines. Mr Chesmar is also an active member of SAE International's CACRC Commercial Aircraft Composite Repair Committee an elite group of industry experts dedicated to the standardization safety security and efficiency of composite repairs in the airline industry. Mr Francois Museux Airbus and Mr William F Cole II also contributed. Care and Repair of Advanced Composites 3rd Edition presents a fully updated approach to the training syllabus recommended for repair design engineers and composite repair mechanics. Metal bonding has been included partly because the definition of composite can be interpreted to include metal skinned honeycomb panels and partly because some composite parts have metal fittings or reinforcements that must be treated before bonding. This third edition also covers a number of the problems experienced in service some of which may be applicable to metallic sandwich panels offers suggestions for design improvements including repair design as a particular topic and regulatory changes. Care and Repair of Advanced Composites 3rd Edition provides solid technical information and training for a wide range of airline staff.

Handbook of Material Weathering George Wypych, 2025-01-23. Handbook of Material Weathering Seventh Edition is an essential guide on the effects of weathering on polymers and industrial products presenting theory stress factors methods of weathering and testing and the effects of additives and environmental stress cracking. The book provides graphical illustrations and numerical data to examine the weathering of major polymers and industrial products including mechanisms of degradation effect of thermal processes and characteristic changes in properties. Final sections discuss recycling corrosion weathering and the weathering of stone. This book is an important reference source for those involved in studying material durability producing materials for outdoor use and actinic exposure research chemists in the photochemistry field chemists and material scientists designing new materials users of manufactured products those who control the quality of manufactured products and students who want to apply their knowledge to real materials. Include theory photophysics and photochemistry stress factors parameters of exposure measurements and climatic conditions methods of weathering laboratory degradation studies sample preparation and specific topics like weathering of polymers the effects of additives environmental stress and more. Provides specific information and numerical data for over 50 polymers and over 40 groups of industrial products including characteristic



changes and degradation mechanisms Covers weathered materials for recycling the interrelation between corrosion and weathering and graphical illustrations and numerical data to examine the weathering of major polymers and industrial products     **Practical Guide to the Assessment of the Useful Life of Rubbers** Roger P. Brown,2001 The object of this publication is to provide practical guidance on assessing the useful service life of rubbers It describes test procedures and extrapolation techniques together with the inherent limitations and problems This Guide seeks to be comprehensive but concentrates on the most common environmental effects causing degradation and the most important mechanical properties of rubbers The test procedures used are outlined and the relevant d104books and International standards are referenced

*International Polymer Science and Technology* ,2004     *British National Bibliography for Report Literature* ,2001

**Rubber Product Failure** Roger P. Brown,2002 Rubber components are used in many demanding applications from tyres and seals to gloves and medical devices and failure can be catastrophic This review of Rubber Product Failure outlines and illustrates the common causes of failure while addressing ways of avoiding it There has been increasing pressure to improve performance so that rubbers can be used at higher temperatures and in harsher environments For example the under the bonnet temperature has increased in some vehicles and new medical devices require longer lifetimes in potentially degrading biological fluids The expectations of tyre performance in particular are increasing and retreads have been in the spotlight for failures The definition of failure depends on the application For example a racing car engine seal that lasts for one race may be acceptable but in a normal car a life span of 10 years is more reasonable If appearance is critical as in surface coatings and paints then discolouration is failure whilst in seals leakage is not acceptable Each rubber product must be fit for the use specified by the consumer Failure analysis is critical to product improvement the cause of the problem can be much harder to find It can range from a design fault to poor material selection to processing problems to manufacturing errors such as poor dimensional tolerances to poor installation product abuse and unexpected service conditions The rubber technologist must become a detective gathering evidence understanding the material type and using deductive reasoning Testing and analysis of failed materials and components add to the information available for failure analysis For example stored aged tyres appeared superficially to be alright for use but on drum testing small cracks grew more quickly than in new tyres leading to rapid failure in service Quality control procedures such as product inspection testing and material quality checks can help to reach 100 percent reliability In critical applications such as electricians gloves for high voltage working gloves are inspected before each use while engine seals may be routinely replaced before the expected lifetime to avoid problems in the literature is not high However several reviews have been written on specific products and references can be found at the end of this review Around 400 abstracts from papers in the Polymer Library are included with an index Subjects covered include tyre wear and failure seals engine components rubber bonding failure rubber failure due to chloramine in water tank treads gloves and condoms medical devices and EPDM roofing membranes

Failure Of Plastics And Rubber Products Causes Effects And Case Studies Involving Degradation: Bestsellers in 2023 The year 2023 has witnessed a noteworthy surge in literary brilliance, with numerous engrossing novels enthralling the hearts of readers worldwide. Lets delve into the realm of bestselling books, exploring the captivating narratives that have captivated audiences this year. The Must-Read : Colleen Hoover's "It Ends with Us" This poignant tale of love, loss, and resilience has gripped readers with its raw and emotional exploration of domestic abuse. Hoover expertly weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can prevail. Failure Of Plastics And Rubber Products Causes Effects And Case Studies Involving Degradation : Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This captivating historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids absorbing storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Failure Of Plastics And Rubber Products Causes Effects And Case Studies Involving Degradation : Delia Owens "Where the Crawdads Sing" This evocative coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens weaves a tale of resilience, survival, and the transformative power of nature, entrancing readers with its evocative prose and mesmerizing setting. These bestselling novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of captivating stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is a brilliant and gripping novel that will keep you speculating until the very end. The novel is a warning tale about the dangers of obsession and the power of evil.

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