Wolfgang Grellmann
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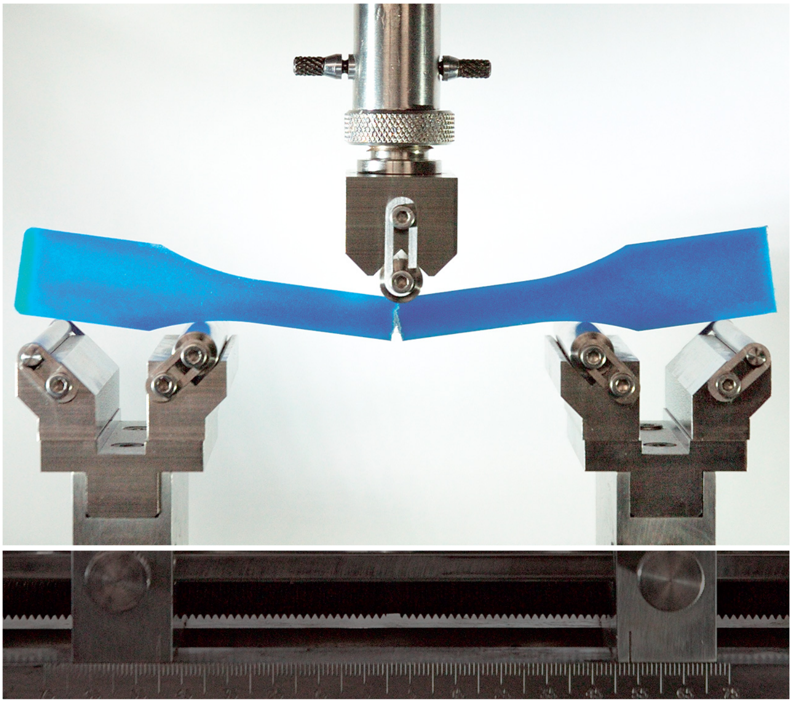
Polymer Testing



2nd Edition

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Wolfgang Grellmann
Sabine Seidler (Eds.)

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Preface to the Second Edition

The textbook „*Polymer Testing*“ is mainly intended for the education of university students and students of universities of applied sciences. This textbook was deemed to be necessary because the testing of polymers has become established as a separate scientific discipline within polymer sciences in recent years. The textbook was first published in German in 2005. An improved English version was published in 2007, and a Russian edition appeared in 2010 with special consideration given to the specific GOST standards.

The positive reviews from our colleagues demonstrate that the concept „Method – Parameters – Examples“ meets students` needs and is also accepted in practice.

Although there have been no significant changes to basic testing methods since the first edition appeared, there have been considerable advances in the evaluation of structure-property correlations and standardisation. It has become increasingly necessary to provide material-scientific parameters to quantify the relationship between microstructure and macroscopic properties. Therefore, it seemed necessary to publish a second edition. The previous edition has been comprehensively revised, and the new edition covers all the latest developments in the field, including all amendments to the most important polymer test standards up to May 2013.

Using the same concept and methodical structure in the presentation of polymer test procedures, the parameters obtained by the latter and the selected examples, the new edition provides university students and students of universities of applied sciences with a good and fast source of information. This is why the textbook has been widely adopted by universities and universities of applied sciences for the teaching of „*Polymer Testing*“.

In order to provide support the lecturers, a PowerPoint presentation has been created for all pictures and tables. It can be downloaded from www.hanserpublications.com. In this regard, we would like to thank Prof. Dr.-Ing. Christian Bierögel, in particular, for his valuable advice in the preparation of this edition and especially for the new publication of the pictures, which are now in colour, and his extensive work on producing the PowerPoint presentation of all pictures.

A Wiki dictionary, „*Plastics Testing and Diagnostics*“, has been produced on the scientific basis of the book and of publications from the Merseburg scientific school, and it often provides more detail than the book. The dictionary is available at www.polymerservice-merseburg.de/wiki-lexikon-kunststoffpruefung and can be used for practical work. An extensive compilation of fracture mechanics test specimens and approximation equations to calculate parameters in fracture mechanics are just two examples of what the dictionary offers.

We would like to thank Carl Hanser Verlag, especially Ms. Dr. N. Warkotsch, Ms. Dr. C. Strohm, Ms. Dipl.-Ing. (FH) U. Wittmann and Mr. S. Jörg, for their much-appreciated and reliable assistance.

June 2013 The Editors

Preface to the First Edition

This book is based on the editors' extensive experience in research, development and education in the field of materials science and especially polymer testing, polymer diagnostics and failure analysis. The results of their work were published in several reference books about deformation and fracture behavior of polymers, in numerous single publications in peer-reviewed scientific journals and in proceedings. Given the fact that the field of science undergoes a rapid and dynamic development it seemed prudent to present these results in a textbook for students.

The following factors convinced us that a comprehensive representation of the state of knowledge was needed:

- The ever-increasing importance of this materials group for continued technical progress led to an increasing share of polymers and compounds in various applications.
- The increased safety awareness led to the development of hybrid methods of polymer diagnostics, which enable a complex view of the connection between loading and material behavior under actual loading conditions and ambient influences
- As a result of the development of fiber-reinforced thermoplastic and thermosetting composite materials, new challenges to polymer testing methods emerged.
- The increasing use of polymers and elastomers in medical technology for various applications requires the development of technological testing methods for viability, serviceability, operating safety and /or service life.
- As a consequence of the trend to miniaturization components (microsystems), more suitable testing methods are necessary for the evaluation of various thermomechanical loadings of materials properties, e.g., in highly integrated electronic components.

In addition, a number of new standards and regulatory codes for polymer testing have been introduced over the past years, further emphasizing the need for a redesigned textbook for this discipline of science. The book presents a comprehensive representation of knowledge provided by respected colleagues from universities, universities of applied sciences and the polymer industry. A list of co-authors as well as acknowledgements for numerous colleagues and co-workers follow on separate pages.

The editors and co-authors tried hard to overcome the limits of classic polymer testing using ASTM and ISO standards in order to make the importance of polymer testing for the development and application of new polymers, composite materials and materials compounds, as well as the introduction of new technologies, more recognizable.

This book is primarily designed for students of bachelor, diploma and master courses of material science, material technology, plastic technology, mechanical engineering, process engineering and chemical engineering. It can be used by students, teachers of universities and colleges for supplementary studies in the disciplines of chemistry and industrial engineering. The methods of polymer testing are also essential to the development and application of biomedical or nanostructured materials.

With the publication of this book we hope that it will not only serve the important task of training of young scientists in physical and material oriented disciplines, but will also make a contribution to further education of professional polymer testers, design engineers, and technologists.

We thank Carl Hanser Publishers for publishing this book, entitled “Polymer Testing”, especially we are grateful to Dr. Christine Strohm who thoroughly revised the complete text for this edition. We also thank Dr. Paul I. Anderson for the translation of several chapters. The main idea of this book was based on the 1992s book by Dr. Heinz Schmiedel “Handbook of Polymer Testing”, written in German language. We kept the physical-methodical approach and also, the comprehensive chapter “Fracture Toughness Measurements in Engineering Plastics” based on our research work in this field for many years. For example it is pointed out on the extensive collection of fracture mechanics specimen and the evaluation equations for determination of fracture mechanics parameters.

We want to thank sincerely all co-workers from the Center of Engineering Science and the Institute of Polymer Materials e.V. of the Martin-Luther-University of Halle-Wittenberg and all collaborators from the Institute of Materials Science and Technology of the Vienna University of Technology who, with their commitment and their willing cooperation, made the publication of this book possible in the first place.

Sabine Seidler, Vienna — Wolfgang Grellmann, Halle

May 2007

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Polymer Testing focuses on the testing, analysis and characterization of polymer materials, including both synthetic and natural or biobased polymers. Novel testing methods and the testing of novel polymeric materials in bulk, solution and dispersion is covered. In addition, we welcome the submission of the testing of polymeric materials for a wide range of applications and industrial products as well as nanoscale characterization. The scope includes but is not limited to the following main topics