



Adhesives Technology Handbook

Third Edition

**Sina Ebnesajjad
Arthur H. Landrock**

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Adhesives Technology Handbook

Preface to Third Edition

This is a book written primarily for practitioners working with adhesives, bonding materials and parts together, and testing the adhered parts. The third edition, like the second edition, covers various adhesives and their use with metallic and nonmetallic parts. This book does not set out to cover the latest developments in adhesives as published in journals or variation of formulations. Rather it focuses on the needs of the classes of commercial adhesives and using them for manufacturing parts and components. Secondly, theoretical and scientific topics related to adhesives/adhesion have been covered, albeit briefly, to ensure that the book is useful to the readers interested in those topics. References have been cited for individuals interested in more in-depth investigation of different topics. Information about the adhesive suppliers and—in many cases—website addresses have been included in the book to facilitate finding those products.

Adhesives are polymeric materials which have been in use for centuries; a short history has been included in this book. Over time, many families of adhesives have been developed to the extent that it is rare to hear of a truly new class adhesives. Yet research in understanding the mechanisms of adhesion has continued. Many new developments in adhesives have been products of research and development in the military laboratories and aerospace industries. Post World War II growth of consumer products has been another driver of adhesive development. Some of the technologies developed decades ago have been modified and are still used. This is why some of the old references in this book have been retained throughout the revisions.

With respect to the use of biobased sources, adhesive products have been ahead of plastics. They are often called *natural* adhesives. Animal- and plant-based adhesives have been used for thousands of years. Three prominent classes of natural adhesives include proteins (polyamides), carbohydrates (polysaccharides), and natural rubber (mainly *cis*-polyisoprene). Three specific examples are: starch, a carbohydrate; gelatin, a protein; and rubber cement made from natural rubber. Advantages of biobased adhesives include recyclability and environmental safety. The latter is an important consideration because of presence of solvents and hazardous ingredients in some synthetic adhesives.

This book is in its third edition and has been widely accepted by readers. The book has been revised without altering the basic structure of the book.

Every chapter of the book has been revised and updated as required. New figures, tables, and data have been added to some of the chapters. Chapter 3 has been streamlined in recognition of availability of better references, including two books from Elsevier. A number of new references in the book refer the reader to suppliers of adhesives and allied equipment. Usually, these companies not only provide information about the adhesives but also about application technologies and required equipment.

Chapter 10 is entirely new. It focuses on adhesives used in direct physiological contact in dental and medical procedures. Many of these adhesives are based on acrylics chemistry; some, such as cyanoacrylates, are used in other applications. Activity in both areas has been quite extensive outside the United States for decades. In contrast, adhesive use in medical devices, patches, and plasters has been ongoing in the United States for a long time. In the case of medical devices, adhesion is concerned with the joining of materials such as plastics, elastomers, textiles, metals, and ceramics. In contrast, the coverage of this chapter is devoted to applications where the adhesives are in direct contact with tissues and other live organs.

None of the views or information presented in this book reflects the opinion of any of the companies or individuals that have contributed to the book. If there are errors, they are oversight on the part of the author. A note indicating the specific error to the author or to the publisher, to allow prompt correction of electronic files, is much appreciated.

Sina Ebnesajjad
Chadds Ford, PA
November 2014

Preface to Second Edition

I was asked by the publisher to update Arthur Landrock's *Adhesives Technology Handbook*, which was first released in 1985 by Noyes Publishing. I have taken advantage of almost every bit of the material in the Landrock book by updating, revising, and including them in the present book.

There are many books about adhesives. Several excellent books are available that deal with the subject of adhesives from different points of view. Some have looked at adhesives from synthesis, chemistry, or bonding techniques points of view. Others have treated the subject from a practical standpoint. Of these, most are attempts to describe adhesion to a variety of materials including plastics, metals, wood, etc. A few books are highly specialized in the applications of adhesives in a particular industry such as metals or construction.

What is different about this book? The present book is focused on practitioners of adhesion technology from an end user's point of view, thus covering most substrates such as plastics, metals, elastomers, and ceramics. The information is aimed at allowing readers to select the right adhesive and successfully bond materials together. Every attempt has been made to enhance the accessibility of the information and the reader friendliness of the text. In the balance of practical and theoretical subjects, practical has been given a definite advantage. This is a trade-off that the author readily acknowledges. There are numerous good books and sources for the study of the theory and science of adhesion and adhesives.

The aim of this book is to explain in a simple yet complete manner all that is required to successfully bond different materials. This book is both a reference and a source for learning the basics for those involved in the entire product value chains. Basic principles of adhesion such as surface characterization, types of adhesive bonds, and adhesion failure topics have been covered in addition to a description of common adhesive materials and application techniques. This book offers information helpful to engineers, chemists, students, and all others involved in selecting adhesives and bonding materials together.

Every chapter has been arranged so that it can be studied independently as well as in conjunction with the others. For those who are interested in indepth information, numerous sources have been listed for surface adhesion and polymer science in the pertinent chapters. The references listed at the

end of each chapter serve as both bibliography and additional reading sources. Most of the basic practical technology of adhesives was developed decades ago. Older references have been retained from the Landrock book wherever they represented the preferred source of information for a specific topic. Readers can find a wealth of information and reports that have been declassified by the Defense Technical Information Center (www.dtic.mil), most of which date back to the 1960s and 1970s.

The first three chapters discuss definitions, adhesion theories, surface characterization and analysis, surface energy measurement methods, adhesion mechanism, failure modes, and surface treatment of materials.

Chapters 4–6 describe the adhesives available from a materials standpoint. In Chapter 4, adhesive classification in a number of ways has been described according to the source, function, chemical composition, physical form, and application. Chapter 5 discusses individual adhesive types in detail. As a matter of convenience, the adhesives have been arranged in alphabetical order. Chapter 6 describes adhesives for specific adherend types.

Chapter 7 is devoted to the design of joints. Chapter 8 describes the methods of handling, storage, and application of adhesives to substrates. Solvent cementing has been covered separately in Chapter 9 because of its significance. Chapters 10–12 focus on the methods of testing the strength and durability of adhesive bonds, and quality control assurance.

Chapter 13 deals with economic, environmental, safety, and future trends.

None of the views or information presented in this book reflects the opinion of any of the companies or individuals that have contributed to the book. If there are errors, they are oversight on the part of the author. A note indicating the specific error to the publisher, for the purpose of correction of future editions, would be much appreciated.

Acknowledgments

I would like to pay a special tribute to the late Mr. Arthur Landrock, the author of the first edition of the *Adhesives Technology Handbook*, and included as the co-author of this edition to reflect his historic contributions to the work. He wrote a number of books during his life that helped the industry. Thanks are also due to Rebecca Zale, Trustee of the Rose-Marie Landrock 2007 Revocable Trust, who has been instrumental in enabling this new edition to be published and continuing Arthur Landrock's legacy.

I would like to express my heart-felt appreciation to Matthew Deans, the senior publisher of the Materials Books group at Elsevier, for his leadership and invaluable support. David Jackson, acquisitions editor for plastics engineering and polymers, has supported me throughout this project and others in every possible way. Miss Lisa Jones was the production manager of this book. Lisa's support was vital during the typesetting and production of this book.

I would like to acknowledge my friend Tom Johns, DuPont Information and Computing Group, who has supported me with the finding of sources such as books, papers, patents, and other documents.

My life partner and friend, Ghazale Dastghaib, has given me extensive help with the organization of the chapters of this book. She reviewed every chapter, raised questions, and helped me find answers to them. Her generous support has always come with an ocean of patience and love. I would not have been able to complete this volume without her help.

Sina Ebnesajjad
Chadds Ford, PA
November 2014

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