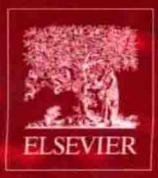

Surface Treatment of Materials for Adhesive Bonding

Second Edition

Sina Ebnesajjad
Assisted by Cyrus F. Ebnesajjad

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Surface Treatment of Materials for Adhesive Bonding

Preface

The first edition (2006) of this book was received well by the practitioners of adhesion, thus prompting a second edition. The second edition is an expansion of the first book. Three new chapters have been added to describe the effect of additives on surface properties and adhesion, surface treatment of ceramics, and adhesion promoters.

Chapter 6 of the first edition describes, dealing with surface treatment methods and techniques. It has been divided into two chapters to focus and devote more space to plasma treatment methods. Both plasma treatment techniques under vacuum and at atmospheric pressure have been covered. These techniques are gaining popularity because they are "dry." The term dry means plasma treatment does not require wet chemicals, which often generate toxic chemical waste that needs disposal. The necessity of reducing the environmental impact of surface treatment operations has generated a great deal of research and development in the area of plasma technologies. Even though plasma treatment techniques require small amounts of gases, they are considered environmentally safe and friendly.

Chapter 10, dealing with the effect of additives on surface treatment of plastics, delves into the impact of additives on surface tension, and the fact that adherability of a material can be positive, neutral, or negative. Some additives actually enhance the bondability of a surface, some have little or no effect, and finally some including silicones and fluoropolymers reduce the ability of a surface to form a bond using an adhesive.

Chapter 11, dealing with surface treatment of ceramics, focuses on the surface treatment of this important group of materials. Ceramics have innumerable applications in industry, dental restorations, consumer products, and art. In addition to ceramics which occur naturally, many new ceramics have been (and continue to be) developed for special applications. By and large, developments in dental restoration have led to the creation of the largest number of ceramics.

Chapter 12, dealing with adhesion promoters, authored by Dr. Peter Pape, sheds light on the use of silanes and other adhesion promoters. Adhesion promoters, or coupling agents, are chemicals that act at the interface between an organic polymer and an inorganic substrate to enhance adhesion between the two materials.

Some readers have commented about the space devoted to the discussion of fluoropolymers. The answer is that fluoropolymers are simply the most difficult plastics to bond. Traditionally, sodium etching has been used to

render the surface of prefluoropolymers such as polytetrafluoroethylene bondable. These plastics represent one extreme type of material because of their unique low surface energy (<40 dynes/cm) and nonwetting characteristics. The other end of the spectrum of materials include metal oxides and metals which have high surface energy (>100 dynes/cm). In spite of the relatively small volume of fluoropolymer consumption, as compared to say polyolefins, they play extremely important roles in human life. Applications include medical devices such as pacemakers, automotive applications, fuel and hydraulic hoses in aerospace, chemical processing, semiconductor fabrication, pharmaceuticals, biopharmaceuticals, and food and beverages.

The authors hope that the second edition of the book is helpful to those who deal with surface treatment of materials and adhesion bonding.

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

Sina Ebnesajjad
Cyrus F. Ebnesajjad
2013

Preface to First Edition

A basic industrial process is the bonding of alike and different materials to each other. Adhesion using an *adhesive* has proven to be an effective means of material bonding. This book describes treatment methods that must be applied to a material surface before successful adhesive bonding is possible. There are numerous examples ranging from wallpaper in a house and paint on surfaces, to parts used in the construction of aircraft.

The aim of this text is to explain, in a simple yet complete manner, all that is required to achieve successful adhesion bonding of different materials. Fundamental material considerations have been given priority to enable the use of the contents of this book in different industries. The book is both a reference and a source for learning the basics, and is useful for all involved in the product value chains. The book also offers information helpful to engineers, chemists, students, and all others involved in material adhesion and processing.

This book is intended to be a handbook for reference of processes and techniques, but it is written with a technical tone. This approach increases the availability of the whole text to readers with a college level background in mathematics and chemistry, but an in-depth knowledge of adhesion technology is not necessary. Chapters 6 through 8 can be used by almost anyone interested in surface treatment of materials and do not require college level background.

The book is organized in two parts. The first five chapters discuss definitions, surface characterization and analysis, surface energy measurement methods, adhesion mechanisms, and failure modes. Chapters 6 through 8 provide extensive information about surface treatment of materials. Chapter 6 is focused on surface preparation and treatment of metals and plastics to render surfaces bondable and to enhance the strength and durability of the bond. This chapter also includes the surface treatment techniques for fluorinated polymers, which are resistant to most techniques. Chapter 7 reviews the techniques applied to specific metals to make them bondable. Chapter 8 describes the surface preparation methods for plastic, thermosetting, and elastomeric materials. Some of the materials in Chapters 7 and 8 are updated from the excellent reference and classic Noyes publication, *Adhesives Technology Handbook*, by Arthur H. Landrock (1985), now out of print.

Attempt has been made throughout the text to balance the practical with the theoretical. Every chapter has been arranged so that it can be studied independently. For those who are interested in in-depth information, content

and references have been provided for surface, adhesion, and polymer science in Chapters 1 through 5. The reader interested only in the practical information can directly consult Chapters 6 through 8. The references listed at the end of each chapter serve as both a bibliography and source for additional reading. Review papers are helpful as a starting point for finding additional sources for concentrated reading in a selected area.

The sole purpose of surface treatment in the present context is to render surfaces adherable. It is virtually impossible to understand or achieve adequate surface preparation and treatment without an intimate knowledge of the science and practice of adhesion.

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 oversights on the part of the authors. A note indicating the specific error to the publisher, for the purpose of correction of future editions, would be much appreciated.

Sina Ebnesajjad
Cyrus F. Ebnesajjad
2006

Acknowledgments

No massive undertaking can be completed without the contributions of many people and organizations. Many companies and individuals have contributed information and data to this book. The authors are grateful to each company and individual for their contributions. Diligent attempts have been made to acknowledge every contributor. Any oversight errors brought to the attention of the publisher or the authors will be corrected in future editions.

The authors wish to offer their sincere appreciation to companies whose information and data appear in this book. It is thanks to the contributions of these companies that the contents of this book are connected to the real world of practice and applications.

We would like to especially thank our friend, Dr. Laurence W. McKeen, for his support with the development of the first edition. He made an in-depth review of the manuscript, suggestions, and corrections, and contributed the section on the grit blasting of metals. We are indebted to Larry for his friendship and care.

Credit goes to later Arthur H. Landrock for the materials updated (found in Chapters 7 and 8 of this book) from his excellent *Adhesives Technology Handbook* (Noyes Publications, 1985).

We honor the memory of our deceased friend Bill Woishnis, the cofounder of William Andrew Publishing (acquired by Elsevier in 2009), for his support of the authors in the development of the first edition of the book.

We would like to thank Matthew Deans, the Senior Publisher of William Andrew, for his leadership and invaluable support. Thanks to Matthew's wisdom and guidance, William Andrew continues to grow in both the number of titles and the breadth of subject matters it offers. David Jackson, Associate Editor in William Andrew, is not only brilliant, but a most pleasant and hardworking young man. We appreciated his support throughout the revision of this book. Ms. Lisa Jones' support during the typesetting and production of this book was invaluable.

Our special thanks go to our assistant Brenna Kirby for her editorial support and assistance with manuscript preparation.

We dedicate this book to our family members, who patiently supported us throughout the entire revision process. Without their generosity and devotion this revision would have not been possible.

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