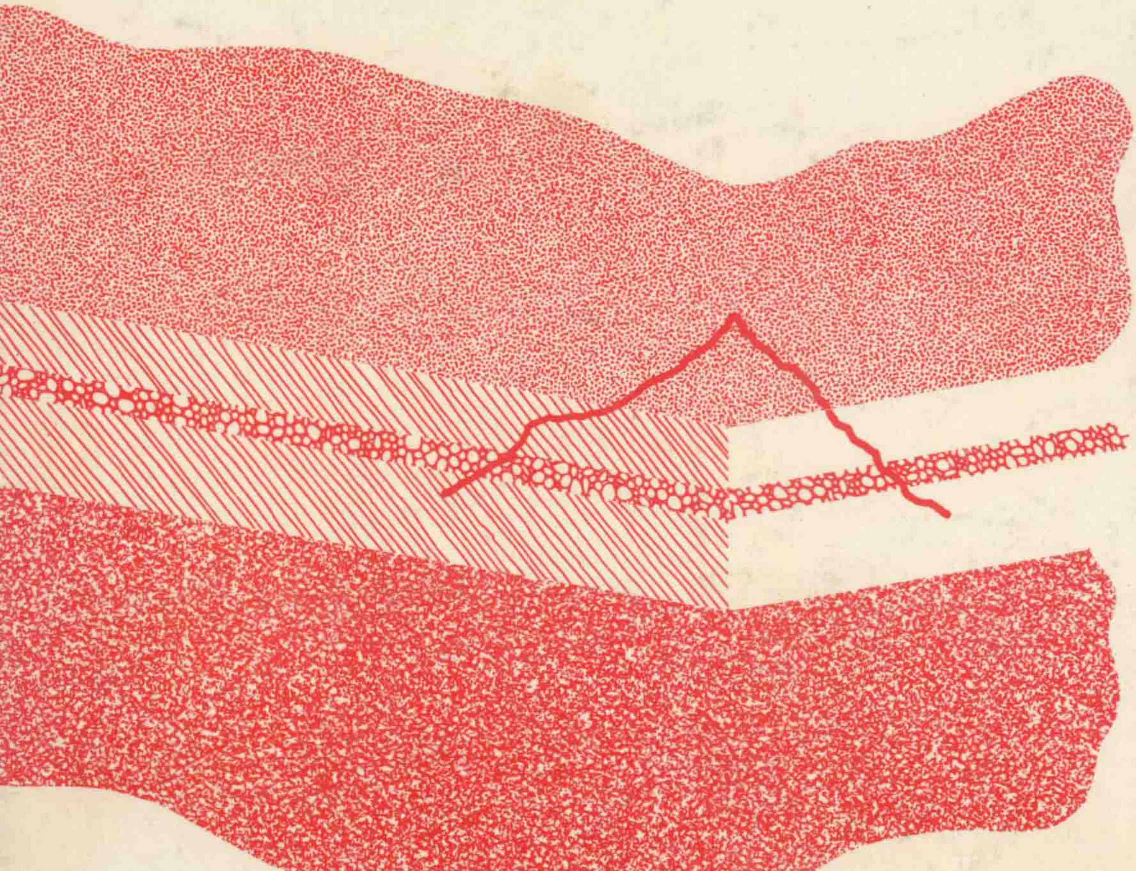
Adhesive Bonding



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Lieng-Huang Lee

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Xerox Corporation
Webster, New York

Plenum Press • New York and London

Library of Congress Cataloging-in-Publication Data

Adhesive bonding / edited by Lieng-Huang Lee.
p. cm.
Includes bibliographical references and indexes.
ISBN 0-306-43471-7
1. Adhesives. I. Lee, Lieng-Huang, date.
TP968.A27 1991
668'.3--dc20 90-15510
CIP

ISBN 0-306-43471-7

A Division of Plenum Publishing Corporation
233 Spring Street, New York, N.Y. 10013

Printed in the United States of America

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Preface

For several years, I have been responsible for organizing and teaching in the fall a short course on "Fundamentals of Adhesion: Theory, Practice, and Applications" at the State University of New York at New Paltz. Every spring I would try to assemble the most pertinent subjects and line up several capable lecturers for the course. However, there has always been one thing missing—an authoritative book that covers most aspects of adhesion and adhesive bonding. Such a book would be used by the participants as a main reference throughout the course and kept as a sourcebook after the course had been completed. On the other hand, this book could not be one of those "All you want to know about" volumes, simply because adhesion is an interdisciplinary and ever-growing field.

For the same reason, it would be very difficult for a single individual, especially me, to undertake the task of writing such a book. Thus, I relied on the principle that one leaves the truly monumental jobs to experts, and I finally succeeded in asking several leading scientists in the field of adhesion to write separate chapters for this collection. Some chapters emphasize theoretical concepts and others experimental techniques. In the humble beginning, we planned to include only twelve chapters. However, we soon realized that such a plan would leave too much ground uncovered, and we resolved to increase the coverage. After the book had evolved into thirty chapters, we started to feel that perhaps our mission had been accomplished. Originally we had thought to publish the entire project under the title *Fundamentals of Adhesion;* then it was deemed necessary to split a portion of it off into this, the second volume, *Adhesive Bonding*. Since these two volumes include chapters by many authors, some overlap is inevitable.

In the first volume, we focused on adhesion with or without the use of an adhesive, and we were chiefly concerned with mechanisms of bond formation. In this volume, we are interested in both bond-forming and bond-breaking processes. Since polymeric adhesives will be at the center of our discussions, we need to know their physical properties as well as their related measurements. After we apply an adhesive to an adherend, we must understand how to determine bond strengths. With data on hand, we should also learn how to analyze the test results and make certain predictions about the durability of adhesive bonds. Though the entire process sounds rather difficult, we hope that readers will find this volume of benefit.

Thus in this volume we shall concentrate on the fundamentals of bonding with the aid of adhesives. Chapter 1 reviews the mechanisms of polymer adhesion and summarizes significant findings from the first volume. This introduction should serve as a bridge between the two volumes. Chapters 2 and 3 introduce rheological aspects of adhesives and adhesion. They are followed by Chapters 4 and 5, discussing measurements of rheological and dynamic properties of adhesives and sealants. Chapters 6 and 7 focus our attention on adherends by showing us new methods of characterizing them and related interfaces. Then Chapter 8 delineates various methods of surface preparation for adherends. Chapter 9 reviews various ways to prepare and determine durable adhesive joints. Chapter 10 serves to introduce new methods in measuring structural adhesive bonds and durability. The following chapters are more theoretical. Chapters 11 and 12 describe somewhat different views on the application of fracture mechanics to adhesive bonding. Chapter 13 is intended to treat some basic concepts about finite-element analysis and its applications to adhesive joints. Chapter 14 illustrates the physics of fracture in terms of fracto-emission. Finally, the last chapter leads us to applications of nondestructive testing (NDT) to adhesive joints. NDT is one of the important test methods for future adhesive and composite technology.

A book of this format can still fail in not covering the subject broadly and deeply enough. Regarding the breadth of the book, we deliberately omitted most of the organic chemistry and formulations of adhesives and sealants because there are other available books dealing with those subjects; two related books edited by me have been published in the last several years: *Adhesive Chemistry: Developments and Trends* (Plenum Press, 1984) and *Adhesives, Sealants, and Coatings for Space and Harsh Environments* (Plenum Press, 1988). Regarding the depth of the book, one may still object that none of the subjects has been treated sufficiently thoroughly. Yet, since this is only an introductory text, it is not our intention to discuss each subject at length. In fact, each chapter could have readily been expanded into a separate book, had that been the goal.

For better readability, all of the chapters have been refereed and separate nomenclature lists are included at the end of most of the chapters. I should like to take this opportunity to thank the many referees for their efforts. I also wish to thank all of the authors for their fine cooperation and patience. Finally, I sincerely appreciate the support of the Webster Research Center of Xerox Corporation in helping me to complete this task, and the assistance of Mr. F. G. Belli and Ms. E. Jonas of the Technical Information Center in preparing the indexes.

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