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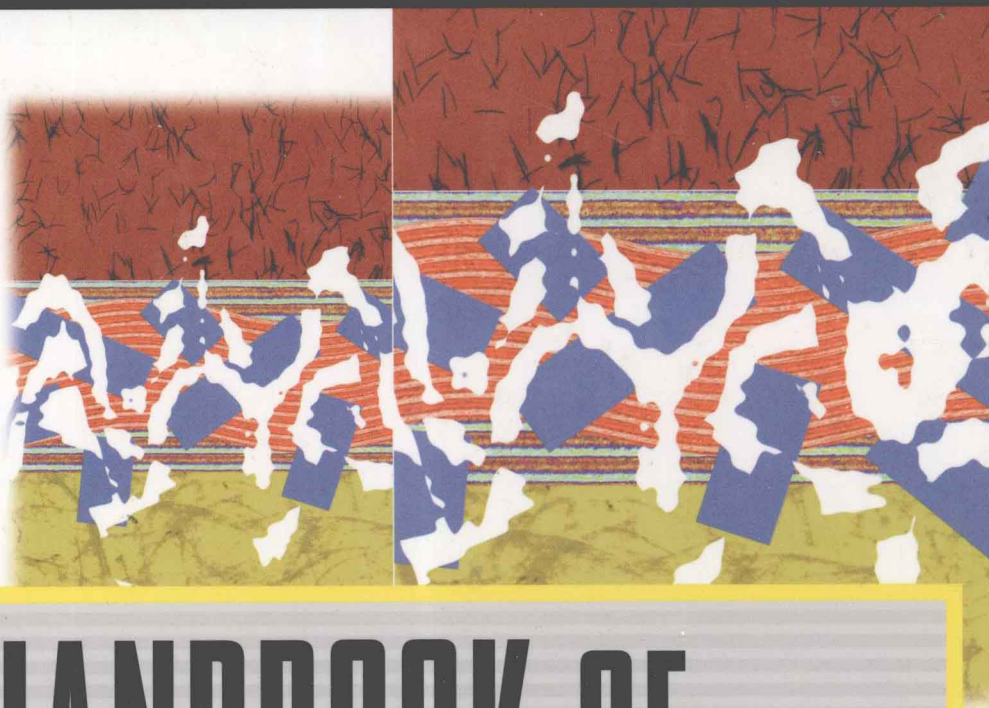

HANDBOOK OF ADHESIVES AND SEALANTS

EDWARD M. PETRIE

Handbook of Adhesives and Sealants

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Handbook of Adhesives and Sealants

Preface

Adhesives and sealants are truly remarkable materials, and I find the technology supporting these materials to be equally extraordinary and at times a bit overpowering for infrequent users of these products. I know of no other technology spread so expansively throughout our lives. It is difficult to imagine a product—in the home, in industry, in transportation, or anywhere else for that matter—that does not use adhesives or sealants in some manner.

Yet, many of us who work with adhesives and sealants, probably "back into" being "experts" almost by default. We had no early intentions of a close relationship with this technology. We went to school and trained, perhaps, to be materials specialists, engineers, designers, or manufacturers. One day our supervisor or the nature of our work demands that we discover how to assemble a product. How do we join together parts to form a functional product that will endure all possible service environments, is harmonious with the company's production processes and schedules, and has some aesthetic and environmental quality? How long will the joint survive in service? What is the repeatability of the process? How do we control the process and check for inferior or improper joints? If the joint is of poor quality, how do we get the parts apart or must they be scrapped? Will the bonding or sealing process affect the environment or the safety of the assembly workers?

In answering these questions, we may have taken a broad, initial approach and considered all forms of assembly including mechanical fasteners, welding, and adhesives. After studying the pros and cons of each process, we possibly choose an adhesive or sealant. Either by good guidance from suppliers, mentors, or just by chance, our first assembled product looks competent. It provides a decent service life, and maybe even results in a profitable product. We are now frequently consulted because we have seemingly mastered a foreboding technol-

ogy that to everyone else has a somewhat sinister demeanor and magical aura about it. Then, we are truly overwhelmed when it becomes obvious that to fully understand and gain expert stature with adhesives and sealants, we must master many fundamental principles. These fundamentals are derived from diverse and alien sciences such as polymeric materials, surface chemistry, and fracture mechanics. To be successful, we know that one must master and integrate these sciences.

The above situation is, of course, magnified a bit, but I am sure that it reaches home to many who pick up this Handbook and desire an efficient method of understanding adhesives and sealants and applying them reliably. As a periodic end-user, you possibly do not have the time or the resources to thoroughly study the various technologies related to adhesives and sealants. You have little desire to wade through volumes of text and product information looking for the specific methods, processes, and possible examples that will apply to the joining application *du jour*. However, you do want such information close-by if the need arises. Above all, you hope to learn from the experiences of others. Ideally for your needs, a single reference source can provide the guidance and fundamental knowledge required for many adhesive bonding or sealing applications. I hope that I am correct in these assumptions, because this is why I have written this Handbook.

There are a number of important handbooks, journals, and papers, on adhesives and sealants already in the literature. Many of these are important works, and they serve as a foundation for this Handbook. To the authors of these remarkable vehicles, I am exceedingly grateful. Much of their work is referred to here. This Handbook may not go into the technical depth that is evident in these previous works. However, it will provide sufficient detail and a broad foundation to enable the practitioner to reliably design, select, and use adhesives or sealants.

This Handbook will be a single, comprehensive source of recent information, historical experience, and guidance for any adhesive or sealant application. The Handbook will define the universe of adhesives and sealants from the perspective of the end-user, and in that way will provide a practical and useful source of information.

My perspective is as an end-user as well. I have consulted on adhesives and sealants for over 33 years in diverse commercial industrial applications, first in Westinghouse Electric Corporation and then in Asea Brown Boveri (ABB) and other companies. Thus, I have seen many successful applications of adhesive or sealant systems and many disasters and near disasters. As an industrial consultant, one generally becomes involved with a case because there is a problem that cannot be solved with the resources at hand. Thus, horror stories as

well as successful applications will litter my presentation. I hope that the readers will find these experiences educational and illuminating.

The *Handbook of Adhesives and Sealants* is a guide to the *entire* field of adhesives and sealants. Although primarily directed toward the end-user and containing important application and design data, the Handbook also provides significant information for those interested in developing, manufacturing, marketing, purchasing, or just generally becoming familiar with these important materials.

The initial chapter covers the importance of adhesives and sealants and the multi-disciplined nature of the technology. Also introduced in the first chapter are markets and applications, the functions of adhesives and sealants, and common materials and processes. Major sources of information regarding adhesives and sealants are identified for readers interested in gaining a deeper understanding or maintaining currency with this dynamic technology.

Subsequent chapters then cover important elements necessary to determine where adhesives and sealants should and should not be used and, when indicated, how to successfully use them. Chapters cover adhesion theories, joint design rules, test methods, substrate preparation methods, adhesive and sealant materials, application and processing methods, and the effects of the service environment. The final chapter describes how information technology is changing the selection and knowledge gathering process.

Throughout the Handbook, specific applications and examples illustrate the concepts being discussed. Due to the broad nature of this technology, the reader will often be directed from one section to other relevant sections within the book. References at the end of each chapter direct the interested reader to more in-depth information and understanding regarding specific subjects.

I wish to express a sincere "thank you" to all those who made my goal of putting this Handbook together a reality. Special thanks goes to Charlie Harper for his motivation and support and to Ron Sampson for his mentoring and wisdom in my early days as a young research engineer.

Edward M. Petrie

Acknowledgment

This book is dedicated to my wife, Carol—who is everything to me including proofreader, motivator, and friend; and to my son, Eddie. I also dedicate this book to all those excellent engineers and technicians that I have known in my years at Westinghouse Corporation. Thank you for the experiences, many of which are in this book, that made my early career worthwhile and never boring.

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