

Preface

Adhesion is a term with many facets and different meanings to people but we always imply that there is a joint of different materials that can resist mechanical loading.

In fundamental research, fundamental adhesion first of all summarizes all elementary processes at the interface that make two solid materials stick together. That interface is formed when one of the materials in a liquid state (the adhesive) is brought into contact with the other solid one (the adherend) and then solidifies. Close contact between the wetting adhesive molecules and the solid surface give rise to attractive forces known as physical intermolecular interactions (Van der Waals forces), as chemical bonds of any form or as the electric double layer which is created by mobile charges that interdiffuse through the contact due to the initial difference of electrochemical potential between adhesive and adherend. These three types of interactions are in mind when we speak about fundamental adhesion processes. In most cases, adhesives are based on polymers, either as part of the adhesive composition or polymerizing inside the adhesive after it has been brought in contact with the adherend. In compatible polymer-polymer composites, the macromolecules interdiffuse through the contact and create an interpenetration layer capable to bear mechanical load. Therefore, that interdiffusion process is considered as a fourth fundamental adhesion process. All these adhesion processes have been subject to intense research for many decades now. Nevertheless, we are still far from understanding them in such detail that we could transfer our knowledge straight to the sector of engineering and application.

This current state has to do with the discovery that the action of fundamental adhesion forces is not restricted to the interface. They not only fix some layer of adhesive molecules on the surface of the adherend but they can exert strong influence on the formation of chemical and morphological structure as well as on molecular mobility in the adjacent region of the adhesive during solidification. Hence an *interphase* is formed. These interphases depend on the combination of adhesive and adherend surface and on the process of contact formation as well. Due to its distinct structure, the interphase possesses properties that can be much different from the behavior of the bulk adhesive. Compared to the complexity of the problem, we just start understanding what is behind interphases.

Looking at the field of applied research, engineering and technology, adhesion might be related first of all with adhesive joints for most different materials and

most different purposes everywhere in industry today. Moreover, adhesion plays a crucial role in any kind of material composite, in lacquers, paints, coatings as well as on membranes and thin films. Self-cleaning surfaces, friction and wear are other issues where adhesion is involved. Entering biology and medicine, we find most complex processes of cell adhesion and for protein adhesion on surfaces which are key problems in biocompatibility of materials for prosthetics, stents, artificial organs, suture material and surgical glues, just to mention some examples.

That almost endless list of applications with the vast variability of demands is creating new questions to researchers and engineers every day. At the first glance, aspects of practical adhesion like mechanical deformation behavior, strength and durability under duty conditions are in the focus of interest. However, we have been learning from the materials testing conducted for many decades that understanding of the technical performance of adhesive joints and material compounds needs the knowledge about the fundamental processes that influence and change structure and chemistry in the adhesive. This technical challenge creates broad and continuing research efforts. It is an important task to make the results accessible to everyone interested in adhesion both from the scientific and the practical point of view.

This book provides a collection of 34 contributions on many aspects of adhesion research and application written by scientists from around the globe. Their texts are based on lectures held at the 7th European Conference on Adhesion (EURADH) in Freiburg (Germany) in September 2004 which was organized by the German DECHEMA (Society for Chemical Engineering and Biotechnology) in cooperation with the French Section Française de l'Adhésion of the Société Française du Vide and the British Society for Adhesion and Adhesives.

On that basis, the book intends to bridge current issues, aspects and interests from fundamental research to technical applications. In seven chapters, the reader will find an arrangement of latest results on fundamental aspects of adhesion, on adhesion in biology, on chemistry for adhesive formulation, on surface chemistry and pretreatment of adherends, on mechanical issues, non-destructive testing and durability of adhesive joints, and on advanced technical applications of adhesive joints. Prominent scientists review the current state of knowledge about the role of chemical bonds in adhesion, about new resins and nanocomposites for adhesives, and about the role of macromolecular architecture for the properties of hot melt and pressure sensitive adhesives. Thus, insight into detailed results and broader overviews as well can be gained from the book.

Finally, the editor would like to express his sincere thanks to all authors who have contributed to that book. We all thank Dr. Hubert Pelc of Wiley-VCH and all other staff involved for their helpful assistance in preparing this book, and we hope that our readers from the scientific community and from application and engineering will benefit from the result of our work.