

**McGraw-Hill**

**PROFESSIONAL  
ENGINEERING**



- Step-by-step method for analyzing adhesive bonds and their defects
- Offers the latest in biotechnology
- Explores the properties of polymeric mixtures

# Adhesion of Polymers

**Roman A. Veselovsky / Vladimir N. Kestelman**

---

# Contents

## Preface ix

<b>Chapter 1. The Process of Adhesive-Bonded Joint Formation</b>	<b>1</b>
<b>Chapter 2. Adhesive Properties Control by Surface-Active Substances</b>	<b>22</b>
2.1 Alteration of Properties of Polymeric Composites under the Influence of Surface-Active Substances	22
2.2 Colloid-Chemical Properties of Surfactants in Heterochain Oligomers	25
2.3 Surface Tension of Heterochain Oligomers with Surfactant Additives	33
2.4 Surface Tension of Curling Oligomers	38
2.5 Effect of Surface-Active Substances on the Thermodynamic and Physical-Chemical Properties of Solid Polymers	45
2.6 Oligomer-Metal Interphase Tension	60
2.7 Control of Polymer Adhesion Strength by Means of Surfactant	67
2.8 Influence of Surfactants on the Structure of Polymers	74
2.8.1 Influence of Surfactants on the Structure of Polyurethanes	74
2.8.2 Influence of Surfactants on the Structure of Polyepoxides	81
2.8.3 Influence of Surfactants on Curing Processes and Structure of Unsaturated Polyesters	89
<b>Chapter 3. Properties of Adhesives Based on Polymeric Mixtures</b>	<b>98</b>
3.1 General	98
3.2 Adhesives Based on Interpenetrating Polymer Networks	102
3.2.1 Properties of Sprut-5M Adhesive-Based Reinforced Coatings	109
3.3 Adhesives Based on Thermodynamically Incompatible Polymeric Mixtures	112
3.3.1 Adhesives Based on Acrylic Polymer Mixtures	112
3.3.2 Controlling the Properties of Adhesives Based on Epoxy Rubber Polymeric Mixtures	128
3.3.3 Modification of EP-20 Epoxy-Diane Resin by Epoxidized Polypropylene Glycol (Laproxides 503M and 703)	160
3.3.4 Influence of Surfactants on Structure and Properties of Polyurethanes Based on Oligomer Mixtures	164
3.4 Organo-Mineral Composites	202

3.4.1 Consumption of Polyisocyanate Isocyanate Groups in OMC Formation Processes	203
3.4.2 Influence of "Silica Modulus" on OMC End Product Composition	205
3.4.3 The Role of MGF-9 Oligoetheracrylate in the OMC Formation Process	209
3.4.4 Influence of Hydroxyl Anion on the Processes Occurring in the inorganic Component During OMC Formation	215
3.4.5 Strength Characteristics of Organo-Mineral Composites	217
<b>Chapter 4. Internal Stresses in Adhesive-Bonded Joints and Ways of Decreasing Them</b>	<b>227</b>
4.1 Effects of Internal Stresses on Properties of Adhesive-Bonded Joints	227
4.2 Determination of Internal Stresses in Adhesive-Bonded Joints	229
4.2.1 Thermal Stresses in Adhesive-Bonded Joints	230
4.2.2 Shrinkage Internal Stresses in Adhesive-Bonded Joints	237
4.2.3 Calculation of Internal Stresses by the Lattice Cell Method	244
4.2.4 Edge Internal Stresses in Adhesive-Bonded Joints	251
4.3 Method of Decreasing Internal Stresses in Adhesive-Bonded Joints	252
4.3.1 Effect of Surfactant on Internal Stresses in Adhesive-Bonded Joints	254
4.3.2 Controlling Internal Stresses in Adhesive-Bonded Joints by Taking Account of the Separation in Time of the Formation of Linear and Crosslinked Polymers	256
4.3.3 Decrease of Internal Stresses in Adhesive-Bonded Joints Using Adhesives Based on Interpenetrating Networks	259
4.3.4 Methods of Decreasing Edge Internal Stresses in Adhesive-Bonded Joints	260
<b>Chapter 5. Cementing and Operation of Adhesive-Bonded Joints in Liquid Media</b>	<b>263</b>
5.1 Cementing in Liquid Media	263
5.2 Effect of Liquids on the Properties of Adhesive-Bonded Joints	267
<b>Chapter 6. Adhesion and Molecular Mobility of Filled Polymers</b>	<b>278</b>
6.1 Control of Polymer-to-Solid Surface Adhesive Bond Strength by Addition of Fillers	278
6.2 Influence of the Molecular Size of the Filler Surface Modifier on the Strength of Adhesive Bonds with Solid Substrates and the Molecular Mobility of the Filled Polyurethane	283
6.3 Molecular Mobility in Filled Polyurethanes and Their Adhesion Properties at Different Filler Concentrations	285
6.4 Influence of Aerosil Modification on the Aggregation of Particles in Oligomer Medium	289
6.5 Structure of the Filled Polyurethane Interphase Layer at the Metal Substrate Boundary	293

<b>Chapter 7. Criteria of Adhesive Joint Strength</b>	<b>298</b>
7.1 Adhesive Joint Strength under Combined Action of Various Stresses	298
7.2 Analysis of Strength Criteria as Applied to Adhesive Joints	308
7.3 Applicability of the Limited Stressed States Theories for Materials Unequally Resistant to Tension and Compression	315
7.4 Analysis of Design and Experimental Diagrams of the Limiting Stressed State	319
<b>Chapter 8. Control of Polymer Properties for Impregnation of Porous Materials</b>	<b>331</b>
8.1 Introduction	331
8.2 Physical-Chemical Aspects of the Impregnation of Porous Materials	333
8.2.1 Adhesion of the Composition to Impregnated Materials	333
8.2.2 Selective Adsorption of Components of the Composition	333
8.2.3 Impregnation of Wet Materials	336
8.3 One-Component Organic Compositions for Impregnation of Porous Materials	337
8.4 Influence of Impregnation on Material Properties	338
<b>Chapter 9. Practical Applications of Polymer Adhesion Studies</b>	<b>342</b>
9.1 Adhesives for In-situ Maintenance and Repair Work	343
9.1.1 Ship Repairs	343
9.1.2 Damage Control in the Oil and Gas Industry	345
9.1.3 Reconstruction of Structural Units and Buildings	356
9.2 Manufacture of Pressware from Cellulose-Containing Materials	363
9.3 Adhesive for Fixing Organic Soft Tissues: KL-3	364
9.3.1 Biodegradation of KL-3 Polyurethane Adhesive	364
9.3.2 Use of KL-3 in Experimental and Clinical Surgery	366
9.4 Cyanoacrylate Adhesive	370
9.5 Use of Polymer Compositions for Nuclear Energy Applications	370
9.6 Quality Enhancement for Articles Made of Porous Materials	371
9.7 Brick and Concrete Paints	371
9.8 Manufacture of Floors	373
9.9 Manufacture of Heat Insulation Panels	373
9.10 Strengthening and Sealing of Rocks	374

<b>References</b>	<b>377</b>
-------------------	------------

<b>Index</b>	<b>389</b>
--------------	------------