

Contents

Volume 2b/1

Introduction see Volume 2b/I	1
1 Simple physical parameters see Volume 2b/I	3
2 Chemical methods of identification of macromolecular systems and their components see Volume 2b/I	21
3 Molecular degradation and analysis of the products of decomposition see Volume 2b/I	43
4 Physical methods of the analysis of macromolecular systems see Volume 2b/I	85
5 Characteristic absorption bands of functional groups and structural components of organic compounds see Volume 2b/I	265
6 Description of the substance classes and their <i>IR</i> spectra: Defined natural and synthetic polymers see Volume 2b/1	321
7 Specific analytical problems see Volume 2b/I	399

Volume 2b/II

Classified bibliography

Notes on the use of the bibliography

1 Books, reviews	461
1.1 Descriptions of materials	461
1.1.1 Polymers general; fibers, elastomers, liquid crystals, polymer mixtures	461
1.1.2 Resins, paints, coatings	461
1.1.3 Additives	462
1.2 Identification, analysis, testing (non-spectroscopic)	462
1.3 <i>IR</i> Spectroscopy	462
1.3.1 Fundamentals	462
1.3.2 Macromolecular systems	463
1.3.3 Additives	464
1.3.4 Compilations of data	464
1.3.5 Computers	465
1.4 Raman spectroscopy	465
1.5 Nuclear and electron spin resonance spectroscopy	465
1.6 <i>UV/VIS</i> spectroscopy	466
1.7 Mass spectrometry	466
1.8 Non-destructive chromatographic methods	467
1.9 Thermal analysis, analytical pyrolysis, polymer degradation and stabilization; other analytical methods	467
2 Methodology of vibrational spectroscopy	468
2.1 Calibration, standards, nomenclature	468
2.2 Instrumentation, preparation techniques	468
2.2.1 Preparation techniques for transmission spectroscopy	468
2.2.2 Measurement at high and low temperatures	468
2.2.3 Micromethods, miscellaneous experimental techniques	468
2.2.4 Measurement of <i>IR</i> dichroism (polarization spectrometry)	469
2.2.5 Measurement of attenuated total reflectance (<i>ATR</i> spectroscopy)	470
2.2.6 Reflectance absorption spectroscopy, diffuse reflectance, other methods of reflectance spectroscopy	471
2.2.7 Photoacoustic <i>IR</i> spectrometry	473
2.2.8 Emission <i>IR</i> spectroscopy	473

2.3 Spectroscopy in near and far infrared	473
2.3.1 <i>NIR</i> spectroscopy	473
2.3.2 <i>FIR</i> spectroscopy	474
2.4 Combination of <i>IR</i> spectroscopy with other methods	475
2.4.1 <i>IR</i> spectroscopy and chromatographic methods	475
2.4.1.1 Liquid chromatography (gel permeation chromatography, <i>HPLC</i>) and <i>IR</i> spectroscopy	475
2.4.1.2 Gas chromatography and <i>IR</i> spectroscopy	475
2.4.1.3 Pyrolysis gas chromatography and <i>IR</i> spectroscopy	476
2.4.2 <i>IR</i> spectroscopy and thermal analysis	476
2.4.3 <i>IR</i> and <i>NMR</i> spectroscopy	477
2.4.4 <i>IR</i> spectroscopy and mass spectrometry	478
2.4.5 <i>IR</i> spectroscopy and <i>X-ray</i> diffraction	478
2.4.6 Combination with other methods	478
2.5 Raman spectroscopy	479
2.5.1 Fundamentals, general investigations of polymers	479
2.5.2 CH polymers	480
2.5.2.1 Polyacetylene (polyvinylene) and poly(diacetylene)	480
2.5.2.2 Polyethylene	480
2.5.2.3 Polypropylene, polybutene-1	481
2.5.2.4 Polystyrene	481
2.5.3 CHal and CHHal polymers	481
2.5.4 CHO polymers	482
2.5.5 CHN and CNO polymers	482
2.5.6 Resins, other binders	482
2.5.7 Miscellaneous polymers, pyrolysates	483
2.5.8 Time-dependent processes	483
2.5.9 Quantitative investigations	483
3 Vibrational spectroscopy of macromolecular systems	484
3.1 Fundamentals	484
3.2 Defined natural and synthetic macromolecules	484
3.2.1 CH polymers	484
3.2.1.1 Polyacetylene and poly(diacetylene)	484
3.2.1.2 Polyethylene	485
3.2.1.3 Polypropylene	485
3.2.1.4 Higher poly(alkylethylene)s	486
3.2.1.5 Polybutadienes	486
3.2.1.6 Polyisoprenes	486
3.2.1.7 Other unsaturated polyhydrocarbons, derivatives of polyenes	486
3.2.1.8 Aliphatic-aromatic and aromatic polyhydrocarbons, miscellaneous polyhydrocarbons	487
3.2.2 Fluorine-containing polymers	487
3.2.3 CCl and CHCl polymers, miscellaneous poly(halohydrocarbons)	487
3.2.4 CHN polymers	488
3.2.5 CHO polymers	488
3.2.5.1 Polymeric alcohols, phenols and ethers	488
3.2.5.2 Polymeric esters	489
3.2.5.3 Miscellaneous CHO polymers, carbons	490
3.2.6 CHNO polymers	491
3.2.7 Organosilicon polymers	492
3.2.8 Miscellaneous polymers	492
3.3 Natural and synthetic fibers	493
3.3.1 Fundamentals, reviews (also conventional methods)	493
3.3.2 Cellulose, cellulose derivatives, other polysaccharides	493
3.3.3 Polyester fibers	494
3.3.4 CHN and CHNO fibers	494
3.3.5 Miscellaneous fibers	494
3.3.6 Fiber mixtures	494
3.4 Elastomers: rubbers	494
3.5 Resins, paints coatings, paint oils	495
3.5.1 Fundamentals, reviews	495
3.5.2 Natural resins and modified natural resins	496
3.5.3 Hydrocarbon resins	496
3.5.4 Phenolic and epoxy resins	496
3.5.5 Ester-type resins	496

3.5.6 Nitrogen-containing resins	497
3.7.7 Paint oils and their components	497
3.5.8 Miscellaneous resins	497
3.6 Miscellaneous technical macromolecular systems	497
3.7 Low molecular weight starting materials, additives	497
4 Special IR spectroscopic problems (CIRS, see 6)	498
4.1 Vibrational spectra and state of order in polymers, mechano-optical investigations, association of polymers	498
4.1.1 Fundamentals	498
4.1.2 Defined polymers	498
4.1.2.1 Polyethylene	498
4.1.2.2 Polypropylene	499
4.1.2.3 Other polyhydrocarbons	499
4.1.2.4 CHal, CHHal and CHN polymers	500
4.1.2.5 CHO polymers	500
4.1.2.5.1 Polymeric alcohols and ethers	500
4.1.2.5.2 Polymeric esters	501
4.1.2.6 CHNO polymers	501
4.1.2.7 Miscellaneous polymers	502
4.1.2.8 Liquid-crystalline polymers, polymer association	502
4.1.2.9 Conformational analysis	502
4.2 Copolymers and polymer mixtures	503
4.2.1 Fundamentals	503
4.2.2 CH copolymers and polymer mixtures	503
4.2.3 CHal and CHHal copolymers and polymer mixtures	504
4.2.4 CHN and CHO and polymer mixtures	505
4.3 End group determination	505
4.4 Starting materials, defined degradation products	506
4.5 Pyrolysates	506
4.6 Time-dependent physical and chemical processes	507
4.7 Hydrogen bonds	508
5 Quantitative IR spectroscopy (without CIRS, see 6)	509
5.1 Fundamentals, functional groups	509
5.2 CH polymers	509
5.3 CHal and CHHal polymers	511
5.4 CHN polymers	512
5.5 CHO polymers	512
5.6 CHNO polymers	513
5.7 Miscellaneous polymers	513
6 Computer-assisted IR spectrometry (CIRS).	514
6.1 Fundamentals	514
6.1.1 Experimental methodology	514
6.1.2 General investigations of polymers	515
6.2 States of order in polymers	515
6.3 Multicomponent polymer systems	517
6.3.1 Polymer mixtures	517
6.3.2 Copolymers	518
6.3.3 Modified fibers, fiber-reinforced or filled materials	518
6.4 Time-dependent physical or chemical processes in macromolecular systems	518
6.4.1 Deformation and relaxation (rheo-optical investigations)	518
6.4.2 Physicochemical and chemical processes	520
6.5 Quantitative CIRS analysis	521
6.6 Miscellaneous CIRS investigations of macromolecular systems	521

6.7 Combination of <i>CIRS</i> with other methods	522
6.7.1 Chromatographic methods and <i>CIRS</i>	522
6.7.2 Thermal analysis and <i>CIRS</i> , Evolved Gas Analysis (<i>EGA</i>)	524
6.7.3 <i>NMR</i> spectroscopy and <i>CIRS</i>	524
6.7.4 Mass spectrometry and <i>CIRS</i>	525
6.7.5 Other combinations with <i>CIRS</i>	525
6.8 Data storage and processing	525
7 Other methods for analysis and structural determination of polymers	527
7.1 Nuclear magnetic resonance spectroscopy	527
7.1.1 Fundamentals	527
7.1.2 Solid state <i>NMR</i>	527
7.1.3 Defined polymers	530
7.1.3.1 CH polymers	530
7.1.3.2 CHal and CHHal polymers	532
7.1.3.3 CHN and CHNO polymers	532
7.1.3.4 CHO polymers	534
7.1.3.5 Miscellaneous polymers, resins	536
7.1.4 End groups	536
7.1.5 Copolymers	537
7.1.6 Polymer blends	539
7.2 Miscellaneous spectrometric methods	540
7.2.1 <i>UV/VIS</i> and fluorescence spectroscopy, circular dichroism and optical rotary dispersion	540
7.2.2 <i>X-Ray-photoelectron</i> spectroscopy	541
7.2.2.1 Fundamentals	541
7.2.2.2 Investigation of surface modification	542
7.2.2.3 Investigation of oxidation and degradation	542
7.2.2.4 CHal and CHHal polymers	543
7.2.2.5 CHN and CHNO polymers	543
7.2.2.6 CHO polymers	543
7.2.2.7 Miscellaneous polymers and resins	544
7.2.3 Electron spin resonance spectrometry (<i>ESR</i>)	544
7.2.4 Miscellaneous spectroscopic methods	546
7.3 Non-destructive chromatographic methods	546
7.4 Thermal analysis	547
7.5 Thermal degradation, analytical pyrolysis	549
7.5.1 Fundamentals	549
7.5.2 Pyrolysis-mass spectrometry (see also 6.7.3 and 7.5.3.9)	550
7.5.2.1 Fundamentals, methodology, general investigations of polymers	550
7.5.2.2 CH, CHal and CHHal polymers	550
7.5.2.3 CHN and CHNO polymers	551
7.5.2.4 CHO and CHS polymers	552
7.5.2.5 Fibers	552
7.5.2.6 Rubbers	552
7.5.2.7 Copolymers and polymer blends	552
7.5.2.8 Resins, miscellaneous macromolecular systems	553
7.5.3 Pyrolysis-gas chromatography	554
7.5.3.1 Fundamentals, methodology	554
7.5.3.2 Polymers general, plastics	554
7.5.3.3 Fibers	555
7.5.3.4 Rubbers	555
7.5.3.5 Copolymers and polymer mixtures	556
7.5.3.6 Resins, coatings	557
7.5.3.7 Miscellaneous macromolecular systems	558
7.5.3.8 Quantitative pyrolysis-gas chromatography	558
7.5.3.9 The coupling of pyrolysis-gas chromatography with other methods (see also 2.4.1 and 6.7.1)	559
7.5.4 Pyrolysis, followed by other chromatographic methods (thermoanalytical)	560
Index	561