

Contents

CHAPTER 1 Nuclear Magnetic Resonance Spectroscopy

By B.E. Mann

| | | |
|---|---|----|
| 1 | Introduction | |
| 2 | Stereochemistry | 2 |
| | Complexes of Groups IA and IIA | 2 |
| | Complexes of Groups IIIA and IVA, the Lanthanides and Actinides | 3 |
| | Complexes of V, Nb, and Ta | 5 |
| | Complexes of Cr, Mo, and W | 6 |
| | Complexes of Mn, Tc, and Re | 14 |
| | Complexes of Fe, Ru, and Os | 15 |
| | Complexes of Co, Rh, and Ir | 22 |
| | Complexes of Ni, Pd, and Pt | 26 |
| | Complexes of Cu, Ag, and Au | 31 |
| | Complexes of Zn, Cd, and Hg | 32 |
| 3 | Dynamic Systems | 33 |
| | Fluxional Molecules | 33 |
| | Lithium | 33 |
| | Beryllium | 34 |
| | Magnesium | 34 |
| | Uranium and Thorium | 34 |
| | Titanium, Zirconium, and Hafnium | 34 |
| | Vanadium | 34 |
| | Niobium and Tantalum | 35 |
| | Chromium, Molybdenum, and Tungsten | 35 |
| | Manganese and Rhenium | 37 |
| | Iron, Ruthenium, and Osmium | 38 |
| | Cobalt, Rhodium, and Iridium | 39 |
| | Palladium and Platinum | 41 |
| | Copper, Silver, and Gold | 42 |
| | Zinc | 43 |
| | Mercury | 43 |
| | Boron | 43 |
| | Aluminium | 43 |
| | Gallium | 43 |
| | Carbon | 43 |
| | Silicon | 43 |
| | Gallium, Tin, and Lead | 44 |
| | Phosphorus | 44 |
| | Selenium | 45 |
| | Tellurium | 45 |

Equilibria

The Alkali Metals
 Magnesium, Calcium, and Strontium
 Lanthanides
 Uranium
 Molybdenum
 Manganese
 Cobalt and Nickel
 Copper
 Aluminium, Gallium, and Indium
 Nitrogen
 Oxygen

Ionic Equilibria

Alkali Metals
 Magnesium
 Calcium
 Yttrium
 Lanthanides and Americium
 Uranium
 Vanadium
 Chromium
 Molybdenum
 Tungsten
 Manganese
 Iron
 Ruthenium
 Osmium
 Cobalt
 Rhodium
 Platinum
 Copper
 Gold
 Zinc
 Cadmium and Mercury
 Boron
 Aluminium
 Thallium
 Carbon
 Silicon
 Tin
 Phosphorus
 Oxygen
 Sulphur
 Chloride

Equilibria Among Uncharged Species

Lithium
 Uranium
 Zirconium
 Vanadium
 Chromium
 Molybdenum and Tungsten
 Manganese
 Rhenium
 Iron
 Ruthenium and Osmium
 Cobalt
 Rhodium and Iridium

| | |
|-----------------------------------|----|
| Palladium | 56 |
| Platinum | 56 |
| Copper | 56 |
| Silver | 56 |
| Gold | 56 |
| Zinc and Cadmium | 56 |
| Mercury | 57 |
| Boron | 57 |
| Aluminium | 57 |
| Silicon | 57 |
| Tin | 57 |
| Phosphorus, Arsenic, and Antimony | 58 |

Course of Reactions

| | |
|-----------------------|----|
| Magnesium | |
| Thorium | |
| Titanium | |
| Tantalum | |
| Chromium | |
| Molybdenum | |
| Tungsten | |
| Manganese and Rhenium | |
| Iron and Ruthenium | |
| Osmium | |
| Cobalt | |
| Rhodium and Iridium | |
| Nickel | |
| Palladium | 62 |
| Platinum | 62 |
| Copper | |
| Mercury | |
| Boron | |
| Aluminium | |
| Thallium | |
| Carbon | |
| Silicon | |
| Tin | |
| Nitrogen | |
| Phosphorus | |

4 Paramagnetic Complexes

The Transition Metals

| |
|-------------------|
| Vanadium |
| Chromium |
| Molybdenum |
| Manganese |
| Technetium |
| Iron |
| Ruthenium |
| Cobalt |
| Iridium |
| Nickel |
| Copper and Silver |

Compounds of the Lanthanides and Actinides

| |
|-------------|
| Lanthanides |
| Actinides |

| | | |
|----|--|----|
| 5 | Solid-state N.M.R. Spectroscopy | |
| | Motion in Solids | |
| | Structure of Solids | |
| | Molecules Sorbed onto Solids | |
| | Water Sorbed onto Solids | 83 |
| | Atoms and Other Molecules Sorbed onto Solids | 84 |
| 6 | Group IIIB Compounds | 86 |
| | Boron Hydrides and Carboranes | 86 |
| | Other Compounds of Boron | 87 |
| | Complexes of Other Group IIIB Elements | 89 |
| 7 | Group IVB Elements | 90 |
| 8 | Compounds of Group VB Elements | |
| 9 | Compounds of Group VIB, Iodine, and Xenon | |
| 10 | Appendix | |
| | References | |

CHAPTER 2 Nuclear Quadrupole Resonance Spectroscopy

By K.B. Dillon

| | | |
|---|--|-----|
| 1 | Introduction | |
| 2 | Main-group Elements | |
| | 2.1 Deuterium | |
| | 2.2 Group I (Lithium-7 and Sodium-23) | |
| | 2.3 Group II (Barium-137) | |
| | 2.4 Group III (Boron-10 and -11, Aluminium-27, and Indium-115) | |
| | 2.5 Group V (Nitrogen-14, Arsenic-75, Antimony-121 and -123, and Bismuth-209) | 199 |
| | 2.6 Group VI (Oxygen-17) | 203 |
| | 2.7 Group VII (Chlorine-35 and -37, Bromine-79 and -81, and Iodine-127) | 203 |
| 3 | Transition Metals and Lanthanides | |
| | 3.1 Copper-63 and -65 | |
| | 3.2 Lanthanum-139 | 214 |
| | 3.3 Europium-151 and -153 | 214 |
| | 3.4 Tantalum-181 | 214 |
| | 3.5 Rhenium-187 | 214 |

References

C
CHAPTER 3 Rotational Spectroscopy

By S. Cradock

| | | |
|---|--|-----|
| 1 | Introduction | 218 |
| 2 | van der Waal's and Hydrogen-bonded Complexes | 218 |
| 3 | Triatomic Molecules and Ions | 220 |
| 4 | Tetra-atomic Molecules and Ions | 223 |
| 5 | Penta-atomic Molecules and Ions | 225 |
| 6 | Molecules with more than 5 Atoms | 226 |
| | References | 231 |

CHAPTER 4 Characteristic Vibrations of Compounds of Main-group Elements

By G. Davidson

| | | |
|---|---|-----|
| 1 | Group I | 238 |
| 2 | Group II | 239 |
| 3 | Group III | 239 |
| | 3.1 Boron | 239 |
| | 3.2 Aluminium | 241 |
| | 3.3 Gallium | 242 |
| | 3.4 Indium and Thalium | 242 |
| 4 | Group IV | 243 |
| | 4.1 Carbon | 243 |
| | 4.2 Silicon | 246 |
| | 4.3 Germanium | 248 |
| | 4.4 Tin and Lead | 248 |
| 5 | Group V | 250 |
| | 5.1 Nitrogen | 250 |
| | 5.2 Phosphorus | 252 |
| | 5.3 Arsenic | 254 |
| | 5.4 Antimony and Bismuth | 254 |
| 6 | Group VI | |
| | 6.1 Oxygen | 255 |
| | 6.2 Sulphur and Selenium Rings and Chains | 256 |
| | 6.3 Other Sulphur and Selenium Compounds | 257 |
| | 6.4 Tellurium | 259 |

- 7 Group VII
- 8 Group VIII

References

CHAPTER 5 Vibrational Spectra of Transition-element Compounds

By G. Davidson

- 1 Scandium, Yttrium and the Lanthanides
- 2 Titanium, Zirconium and Hafnium
- 3 Vanadium, Niobium and Tantalum
- 4 Chromium, Molybdenum and Tungsten
- 5 Manganese, Technetium and Rhenium
- 6 Iron, Ruthenium and Osmium
- 7 Cobalt, Rhodium and Iridium
- 8 Nickel, Palladium and Platinum
- 9 Copper, Silver and Gold
- 10 Zinc, Cadmium and Mercury
- 11 The Actinoids

References

CHAPTER 6 Vibrational Spectra of Some Co-ordinated Ligands

By G. Davidson

Carbon and Silicon Donors

Carbonyl and Thiocarbonyl Complexes

Dihydrogen Complexes

4 Boron-containing Donors

5 Nitrogen Donors

5.1 Molecular Nitrogen, Azido- and Related Complexes

5.2 Amines and Related Ligands

5.3 Ligands Containing >C=N< Groups

| | | |
|-----|--|-----|
| 5.4 | Cyanides, Isocyanides and Related Complexes | 335 |
| 5.5 | Nitrosyls and Thionitrosyls | 337 |
| 6 | Phosphorus Donors | 339 |
| 7 | Oxygen Donors | 341 |
| 7.1 | Molecular Oxygen, Peroxo, Aquo and Related Complexes | 341 |
| 7.2 | Carboxylato and Related Complexes | 343 |
| 7.3 | Keto, Alkoxy, Ether and Related Complexes | 344 |
| 7.4 | Ligands Containing O-N, O-P or O-As Bonds | 346 |
| 7.5 | Ligands Containing O-S or O-Se Bonds | 348 |
| 7.6 | Ligands Containing O-Cl Bonds | 348 |
| 8 | Sulphur and Selenium Donors | 340 |
| 9 | Potentially Ambident Ligands | |
| 9.1 | Cyanates, Thio- and Selenocyanates and their Iso-analogues | 351 |
| 9.2 | Ligands Containing N and O Atoms | 353 |
| 9.3 | Ligands Containing N and S Atoms | 355 |
| 9.4 | Ligands Containing S and O Atoms | 357 |

References

CHAPTER 7 Moessbauer Spectroscopy

By S.J. Clark, J.D. Donaldson, S.M. Grimes, and M.J.K. Thomas

| | | |
|---|---|-----|
| 1 | Introduction | 373 |
| | Books and Reviews | 373 |
| 2 | Theoretical | 375 |
| 3 | Instrumentation and Methodology | 378 |
| 4 | Iron-57 | 381 |
| | General Topics | 381 |
| | Nuclear Parameters and Metallic Iron | 381 |
| | Iron-57 Impurity Studies, Polymers and Ion Exchange | 382 |
| | Frozen Solutions and Matrix Isolation | 383 |
| | Emission Studies | 384 |
| | Compounds of Iron | 385 |
| | High-spin Iron(II) Compounds | 385 |
| | High-spin Iron(III) Compounds | 386 |
| | Intercalation Compounds Containing Iron | 388 |
| | Mixed-valence Compounds and Unusual Electronic States | 389 |

Spin-crossover Systems and Unusual Spin States
 Low-spin and Covalent Compounds
 Biological Systems and Related Compounds

Oxide and Chalcogenide Compounds Containing Iron

General and Hydroxides
 Wuestite, Haematite and Related Oxides
 Magnetite and Spinel-type Oxides
 Other Oxides
 Inorganic Oxide Glasses Containing Iron
 Chalcogenides

Applications of Iron-57 Moessbauer Spectroscopy

Catalysts
 Minerals and Coal
 Ceramics
 Other Applications

5 Tin-119

General Topics
 Inorganic Tin(II) Compounds
 Inorganic Tin(IV) Compounds
 Organotin Compounds

6 Other Elements

Main-group Elements

Germanium (Ge-71)
 Antimony (Sb-121)
 Tellurium (Te-125)
 Iodine (I-127 and I-129)

Transition-metal Elements

Nickel (Ni-61 and Ni-63)
 Zinc (Zn-67)
 Ruthenium (Ru-99)
 Tantalum (Ta-181 and Ta-183)
 Tungsten (W-182 and W-183)
 Mercury (Hg-199)
 Gold (Au-197)

Lanthanide and Actinide Elements

Europium (Eu-151)
 Gadolinium (Gd-155)
 Dysprosium (Dy-161)
 Erbium (Er-166)
 Thulium (Tm-169)
 Ytterbium (Yb-170 and Yb-174)
 Neptunium (Np-237)
 Americium (Am-243)

7 Backscatter - Conversion Electron Moessbauer Spectroscopy

| | |
|--------------------------------|-----|
| Films and Implantation Studies | 444 |
| Steels and Corrosion Products | 447 |
| Alloys | 450 |
| Chemical Reactions | 451 |
| Other Elements | 452 |
| Tin (Sn-119) | 452 |
| Gold (Au-197) | 453 |
| References | 454 |

CHAPTER 8 Gas-phase Molecular Structures Determined by Electron Diffraction

By D.W.H. Rankin and H.E. Robertson

| | |
|--|-----|
| 1 Introduction | |
| 2 Compounds of Elements in Main Group III | 476 |
| 3 Compounds of Elements in Main Group IV | 478 |
| 4 Compounds of Elements in Main Group V | |
| 5 Compounds of Elements in Main Groups VI and VII | |
| 6 Compounds of Transition Elements and Related Main-group Organometallic Compounds | |
| References | 492 |