

Infrared Spectroscopy in Conservation Science

Michele R. Derrick

Dusan Stulik

James M. Landry

1

Contents

	vii	Foreword
	ix	Preface
	xi	Acknowledgments
Chapter 1	1	History of Infrared Spectroscopy
	3	Additional Reading
Chapter 2	4	Infrared Absorption Theory
	4	Electromagnetic Radiation
	4	Wave Theory
	6	Absorption Theory
	8	Molecular Absorptions
	8	Degrees of Freedom
	11	Selection Rules
	11	Group Frequencies
	12	Infrared Spectra
	13	Infrared Regions
	13	Near-Infrared Region
	13	Mid-Infrared Region
	14	Far-Infrared Region
	14	Summary
	15	Additional Reading
a'' Chapter 3	16	Sample Collection and Preparation
	16	Sampling Methodology
	17	Sampling Design
	19	Sampling Location
	20	Sampling Implementation
	20	Tools
	21	Sample Documentation and Storage
	23	Avoidance of Contamination
	24	Sample Collection and Preparation Procedures
	24	Gases
	25	Liquids
	26	Sampling with Swabs

	28	Solids, Powders, and Particles
	32	Fibers
	33	Cross Sections
	42	Summary
	42	Additional Reading
Chapter 4	43	Infrared Analysis Methods
	45	Infrared Transmission Measurements
	46	Infrared Window Materials
	50	Transmission Analysis of Gases
	50	Transmission Analysis of Liquids
	52	Transmission Analysis of Solids
	60	Infrared Reflection Measurements
	62	Specular Reflection
	63	Reflection-Absorption
	63	Diffuse Reflection
	65	Internal Reflection
	68	Infrared Microspectroscopy
	69	Microspectrophotometer Design
	69	Microspectrophotometer Capabilities
	70	Particle and Fiber Analysis
	76	Cross Section Analysis
	79	Microspectrophotometer Accessories
	80	Summary
	80	Additional Reading
Chapter 5	82	Spectral Interpretation
	82	Infrared Spectra
	82	Absorption Bands
	84	Plotting Format
	86	Instrument Configuration
	87	Qualitative Analysis
	87	Spectral Quality
	91	Visual Comparison
	92	Computer Libraries
	93	Spectral Region Examination
	95	Spectra-Structure Correlations
	99	Correlation Charts
	100	Identification of Materials Used in Art and Art Conservation
	100	Natural Organic Materials
	109	Synthetic Resins (Polymers)
	113	Colorants
	120	Mixtures
	121	Quantitative Analysis
	124	Mathematical Manipulations of Spectra
	124	Subtraction Techniques
	125	Resolution Enhancement Methods
	125 127	Resolution Enhancement Methods Summary

130	Case Studies
130	Identification and Characterization of Materials
133	Deterioration Studies
134	The Case Studies
134	Case Study 1: Ultramarine Pigments
138	Case Study 2: Creosote Lac Resin
141	Case Study 3: Chumash Indian Paints
144	Case Study 4: Varnish on a Desk
148	Case Study 5: Reflection versus Transmission
152	Case Study 6: Painting Cross Sections
155	Case Study 7: Vikane
159	Case Study 8: Parylene
163	Case Study 9: Cellulose Nitrate Sculptures
166	Case Study 10: Dead Sea Scrolls
	•
171	Summary
171 172	-
	Summary Appendix I: Selected Infrared Spectra Collections and
172	Summary Appendix I: Selected Infrared Spectra Collections and Digitized Libraries
172 178	Summary Appendix I: Selected Infrared Spectra Collections and Digitized Libraries Appendix II: Infrared Reference Spectra
172 178 201	Appendix I: Selected Infrared Spectra Collections and Digitized Libraries Appendix II: Infrared Reference Spectra Glossary
172 178 201 205	Appendix I: Selected Infrared Spectra Collections and Digitized Libraries Appendix II: Infrared Reference Spectra Glossary Suppliers

236

About the Authors

Chapter 6