CONTENTS

ix

1

Preface

Introductory Review

	Internal components—The tube envelope—External components—Tube reliability—Heat transfer in electron tubes	
1	Glass The nature of glass—The composition of glass—Gas diffusion through glass—The mechanical strength of glass—Annealing of glass—Strain analysis—Electrolysis in glass—Volume conductivity—Surface conductivity—Dielectric properties—Outgassing of glass—Powdered glass—Solder glass	11
2	Ceramics	83
	Raw materials and body compositions (low-loss steatite, forsterite, zircon, alumina, sapphire, wollastonite, beryllia, magnesia, thoria, titania, zirconia)—Temperature measurement—Metal-ceramic interactions—Fabrication of raw materials and processing techniques—Die construction and design considerations—Precision ceramics—Pyroceram (glass ceramics)—Ductile ceramics	-
3	Mica	128
	Mineralogy—Mining and preparation—Fabrication—Physical properties—Process techniques—Synthetic mica	
4	Carbon and Graphite	148
	Physical and chemical properties—Graphite anodes—Outgassing of graphite—Special techniques and applications	
5	Iron and Steels	174
	Physical characteristics—Chemical properties—Strength of materials—The iron-carbon equilibrium diagram—Stainless steels—Application of stainless steels—Aluminum-clad iron—Magnetic properties of iron and steel	
6	Copper and Copper Alloys	194
	Physical characteristics—Chemical properties—OFHC Brand copper—Copper base alloys—Special processes	
7	Nickel and Nickel Alloys	217
	Physical characteristics—Chemical properties—Commercial wrought nickel and powder—Nickel alloys for grids—Special materials and	

processes (carbonized nickel, high-purity nickel, rolled-powder nickel,

outgassing of nickel)

8	Precious Metals: Silver, Gold, and the Platinum Family (Pt, Pd, Rh, Ir, Os, Ru)	241
	Physical characteristics—Chemical properties—Suppression of primary electron emission—High-temperature thermocouples—Miscellaneous applications	
9	Tungsten	257
	Physical and chemical characteristics of tungsten—Tungsten and oxygen—Applications: thoriated filaments, non-sag filaments—fabrication and processing—Radiation damage	
10	Molybdenum	311
	Physical characteristics—Chemical properties—Mechanical properties—Fabrication of molybdenum—Special processes—Radiation damage	
11	Tantalum and Niobium	332
	Physical characteristics—Chemical properties—Mechanical properties—Fabrication—Outgassing of tantalum—Alloys of tantalum	
12	Joining of Metals by Brazing	358
	Brazing metallurgy—The strength of brazed joints—Brazing techniques and joint design—Typical metal combinations (copper/copper, copper/nickel, copper/steel, copper/Kovar, nickel/nickel, stainless steel, tungsten/molybdenum, titanium, beryllium)—Ultrasonic welding	
13	Glass-to-Metal Sealing	394
	Classification of seals—Stresses in seals—Houskeeper seals—Induction seals—Sealing to pure metals (platinum, copper, nickel, iron, tungsten, molybdenum, titanium, zirconium)—Alloy seals (nickel/iron, chrome/iron, nickel/chrome/iron, nickel/cobalt/iron—Processing of Kovar parts—Silver chloride seals—Fused silica-to-metal seals	
14	Ceramic-to-Metal Sealing	470
	History of ceramic tube development—Bond formation and sealing techniques—The sintered metal powder process—Active alloy seals—Brazing operations and processing details—Evaluation of ceramic seals	
15	Cathode Materials and Structures	519
gan, coli	Cathode design parameters—Pure metal emitters—Rhenium—Hafnium—Thin-film emitters—Dispenser cathodes—Magnetron cathodes—Pressed and sintered cathodes—Boride cathodes—Thoria cathodes—Barium-Strontium-Calcium oxide cathodes—Nickel-base alloys for oxide cathodes—Nickel alloys for filaments—Cold cathodes	
16	Getter Materials and Their Use	574
	Types of getters (flash getters, coating getters, bulk getters: tantalum, zirconium, thorium, titanium)—Getter-ion pumps	
Ap	pendix	605
	thor Index bject Index	619 628