

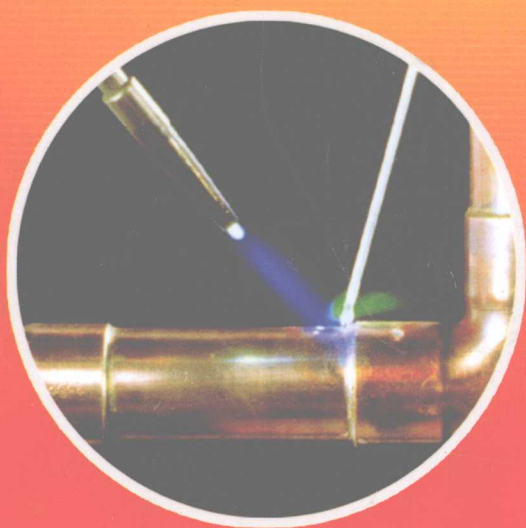


# 钎焊手册

Brazing and Soldering Manual

张启运 庄鸿寿 主编

Zhang Qiyun and Zhuang Hongshou



第 2 版



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## Brazing and Soldering Manual

The Second Edition

Editors-in-Chief ZHANG Qiyun and ZHUANG Hongshou

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这是一本应用理论和实际工作经验总结并重的工具书。全书以被钎焊的母材为主线进行叙述：对铝、铜、钢、不锈钢、高温耐热合金、难熔金属、钛、锆、铍、镁、硬质合金、碳、金刚石、半导体、陶瓷、贵金属、复合材料、特种材料的钎焊，包括部分材料的软钎焊都进行了详尽的介绍。参加本手册每一章编写的作者，都是在该领域中有多年工作经验和科研成果的专家和技术人员，他们在第1版的基础上，收集了大量资料进行修订或重写，因此本书内容有一定的深度和广度。

书中还加强应用理论的阐述，特别是第1章绪论中将界面传质理论通俗地引入钎焊领域，并用以阐明和控制钎焊过程，有较新的意义。

本手册适用于机械、电子、家电等部门从事金属材料精密连接技术工作的科研、生产技术人员，并可供大专院校相关专业师生参考。

This manual is a reference book for brazing and soldering which are thoroughly discussed both in theory and practice. Treatment of the subject follows after the materials to be brazed or soldered rather than method and technique. Aluminum, copper, steel, stainless steel, high melting metal, refractory metal, titanium, zirconium, beryllium, magnesium, carbon, diamond, hard-metal, semiconductor, ceramic, precious metal, composite metal etc and their alloys to be brazed and soldered are described in detail. At the same time, the related materials together with the information are comprehensively collected. The authors are all experts or engineers with broad knowledge and specialized experience in the various fields of brazing and soldering in China. The contents of this manual have a remarkable depth and breadth. In the Chapter 1, the theory of interfacial mass-transfer is introduced into this field for the first time. It is helpful towards contribution to explain and control brazing and soldering process.

All subjects are noted in English translation for foreign interested readers with a glimpse view.

The manual is a suitable reference for producers and engineers who are engaged in the corresponding manufacture and investigation and also teachers and students interested in brazing and soldering.

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## 第2版前言

### Preface of the Second Edition

自从《钎焊手册》第1版1999年问世以来,在我国钎焊技术领域发挥了一定的作用,产生了较好的影响,有比较高的引用率。一些读者反映,这本手册无论形式和内容都比较新颖和丰富,但也存在许多缺陷和不足。转眼间几年过去了,国内外钎焊技术、工艺和设备又有了长足的进展,机械工业出版社有意将本手册修订再版。

本次修订的任务是:①补充手册初版发行以来钎焊领域进展的新资料;②增加初版中未涉及的必要的新内容;③修订初版中的叙述和改正版面上的错误;④对某些章节进行重写。

这次修订编写的原则仍和初版相同:①重实践,丰富资料数据;②重视国内外有关参考文献的引用,作为了解有关内容的进一步延伸;③尽可能描述实践和操作,使实际工作者得以从中获取有用的资料和经验。

修订版采用了分栏的格式。和初版相同,主要标题以及图和表均附英文。

由于作者众多,写作风格各异,每章重点和版式都会有所不同,但这并未妨碍本手册成为一个圆满的整体。多人分工撰写,某些个别内容前后可能会有重复,由于本手册的读者大多一次翻阅只集中于某个别章节,不太会感到全书有内容的重复,反而由于各章自成体系,行文顺畅,避免了因统筹全文而产生“见前”、“见后”的累赘。

初版的撰写有来自全国12位作者共襄盛举。每一位作者都是相关领域从事多年研究和实践工作的学者专家。这本手册是集体创作的结晶,没有大家共同的热心和努力,这种规模的手册便不可能问世,也不可能具有如此丰富和深入的内容。时光流逝,初版的一些作者有的已经退休且长期脱离了有关钎焊的实践;有的虽然仍在工作,但已改弦更张,很久没有涉足原来的钎焊领域,他们表示难于进一步参加手册的修订工作。有鉴于此,本次的修订工作特别邀请了一些正在从事有关科研的、有经验的新作者担纲,在初版的基础上进行修订或重写。感谢他们对编写本手册工作的热心支持。与此同时,也深深感谢初版的作者,他们为本手册有关章节的撰写奠定了坚实的基础。

应该指出,由于某些原因或必要性,个别章节保持了原内容,基本未作更动。

第2版撰写的作者已扩充到了16人,仍由张启运、庄鸿寿主编,各章的编写分工如下:

- |         |                             |
|---------|-----------------------------|
| 第1、2章   | 张启运(北京大学)                   |
| 第3章     | 庄鸿寿(北京航空航天大学)、虞觉奇(湖南大学)     |
| 第4章     | 吴懿平(华中科技大学)                 |
| 第5、6、7章 | 庄鸿寿(北京航空航天大学)               |
| 第8章     | 田招弟(北京真空电子技术研究所)            |
| 第9章     | 李晓红(北京航空材料研究院)              |
| 第10章    | 庄鸿寿(北京航空航天大学)               |
| 第11、12章 | 龙伟民(郑州机械研究所)                |
| 第13章    | 吴坦(北京电子管厂)、田招弟(北京真空电子技术研究所) |

- 第14章 吴爱萍 (清华大学)
- 第15章 张永清 (中国科学院电子学研究所)、陈沛生 (北京真空电子技术研究所)
- 第16章 刘泽光 (昆明贵金属研究所)
- 第17章 李晓红 (北京航空材料研究院)
- 第18章 李晓红 (北京航空材料研究院)、毛唯 (北京航空材料研究院)
- 第19章 刘秀忠 (山东大学)、张启运 (北京大学)
- 第20章 曲文卿 (北京航空航天大学)、庄鸿寿 (北京航空航天大学)
- 第21章 庄鸿寿 (北京航空航天大学)
- 第22、23章 邱惠中 (航天材料及工艺研究所)
- 第24章 陈沛生 (北京真空电子技术研究所)
- 第25章 薛松柏 (南京航空航天大学)

最后,我们全体作者还要向广大的读者和关心本手册的学者、专家致意:当今钎焊技术和其他学科一样,发展日新月异,尽管我们已经竭尽所能,将自己所知、所熟悉的知识写出来,看来还是很难跟上国内外发展的步伐。加上我们个人所处环境和学识的局限,总会存在孤陋寡闻,又会发表些一孔之见,衷心希望广大读者和专家、学者对书中的缺陷、不足和错误提出批评指正。

编者

2008年10月

# 第1版前言

## Preface of the First Edition

钎焊是当今高技术中一项精密的连接技术，在航天、航空、汽车、化工、机械、电子和家电等军用、民用工业中得到广泛的应用。我国目前正处于钎焊技术迅速发展的阶段，在高校、研究单位和工厂中从事科研和应用的工作者以十万计。

世界发达国家如美国、日本、前苏联等都有自己的《钎焊手册》出版，其中美国焊接学会钎焊委员会编的《钎焊手册》和《软钎焊手册》在我国已有中译本。我国多年来尚未有比较完善充实、专门的钎焊手册出版。在国外出版的有关钎焊的手册中，虽各有特色但多有不尽人意之处，例如有的只偏重于综述，具体的钎焊内容只一带而过；有的又过于偏重设备和装置的叙述而较少重视钎焊过程的各个重要环节和重要数据、资料的交代。鉴于这种情况，在机械工业出版社的倡导下，邀请了国内多位在高校、研究单位和工厂工作多年的、有钎焊实践经验的学者和专家来共同编写了这本具有中国特色的《钎焊手册》，它资料丰富、内容翔实、原理与实际并重，而且能充分反映我国钎焊的水平并力争能跟上世界前进的步伐。

本手册特点是便于读者获得钎焊有关的资料、信息和知识；它具有一定的起点而又不是一本多篇论文的专著；本手册条目分明，易于查找，每一部分又以一定深度（包括原理、材料和工艺）进行叙述，既适用于不同水平的工作者解决生产问题，又适用于有关单位进一步开展研究工作的需要。书中以被钎焊的母材为主线展开各个章节的叙述，而不用那种以方法和材料为主线的横向写作方式。我们认为所采取的这种方式既有利于读者的查找，又有利于作者充分展开自己的专长和经验介绍。当然这种写作方式难免会出现一些重复，我们已尽力进行了协调。

本手册还努力评述、汇集了世界钎焊科技近20年来的最新成就并引入文献，以备那些想进一步深入研究的读者得以索引。

本书还有一个特点是对标题和图表均注入了英文，我们衷心希望这本书能走向世界。此外，在华人世界里不乏广大的专家同行，但由于多年的隔离，名词术语多不统一，我们也希望英译文能使大家取得更多的沟通。

经过各位作者一年多的共同努力，这本手册终于和读者见面了，反观起来，和我们原先的设想还有相当的距离，也还有不少欠妥之处，希望对本手册感兴趣的读者不吝指教，使这本手册能够更臻于完善。

编者

1998年10月

# 目 录

## Contents

### 第2版前言 Preface of the Second Edition

### 第1版前言 Preface of the First Edition

|                                                                                                                                                            |    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 第1章 绪论 Chapter 1 Introduction .....                                                                                                                        | 1  |
| 1.1 钎焊方法的原则和特点 Principle and Characteristic of Brazing and Soldering Technique .....                                                                       | 1  |
| 1.2 熔态钎料对固体母材的润湿和铺展 The Wetting and Spreading of Molten Filler Metal<br>on a Solid Base Metal .....                                                        | 1  |
| 1.2.1 固体金属的表面结构 The Surface Structure of Solid Metal .....                                                                                                 | 1  |
| 1.2.2 熔态钎料与固体母材的润湿 Wetting of Molten Filler on Solid Base Metal .....                                                                                      | 2  |
| 1.2.3 熔态钎料在钎剂(第二液体)中与母材间界面张力的变化 The Change of Interfacial Tension<br>between Molten Filler and Base Metal Immersed in a Fused Flux (a second liquid) ..... | 3  |
| 1.2.4 金属母材表面的氧化膜及其去除机制 Oxide Film on Base Metal and its Removal<br>Mechanism .....                                                                         | 4  |
| 1.2.5 熔态钎料在固体母材上的铺展 Spreading of Molten Filler Metal on Solid Base<br>Metal .....                                                                          | 6  |
| 1.3 熔态钎料与固体母材的相互作用 Reaction of Molten Filler with Solid Base Metal .....                                                                                   | 8  |
| 1.3.1 熔态金属与固体金属的相互作用 Reaction of Molten Metal with Solid Metal .....                                                                                       | 8  |
| 1.3.2 钎料的构成 Construction of Filler Metals .....                                                                                                            | 10 |
| 1.3.3 熔态钎料在母材间隙中的流动和钎缝结构的不均匀性 Flowing of Molten Filler Metal in the<br>Clearance of Base Metals as well as Inhomogeneity of the Formed Fillet .....        | 10 |
| 1.3.4 熔析与熔蚀 Liquation and Erosion .....                                                                                                                    | 11 |
| 1.4 钎缝中熔态钎料的凝固和钎缝的金相组织 Solidification of Molten Filler Metal in Clearance and<br>the Micrographic Structure of the Fillet .....                            | 12 |
| 1.4.1 共晶钎缝组织 The Structure of Eutectic Fillet .....                                                                                                        | 12 |
| 1.4.2 晶间渗透组织 The Fillet Structure with Intercrystalline Penetration .....                                                                                  | 12 |
| 1.4.3 有化合物生成的钎缝组织 The Fillet Structure with Intermetallics .....                                                                                           | 13 |
| 1.5 钎剂、钎料的选择与搭配 Selection and Matching of Fluxes with Filler Metals .....                                                                                  | 14 |
| 1.5.1 钎剂的选择 Selection of Fluxes .....                                                                                                                      | 14 |
| 1.5.2 钎料的选择 Selection of Filler Metals .....                                                                                                               | 16 |
| 1.5.3 钎剂和钎料的搭配 Matching of Filler Metal with Flux .....                                                                                                    | 17 |
| 1.6 钎焊工艺 Technology of Brazing and Soldering .....                                                                                                         | 17 |
| 1.6.1 接头的形式与钎料在钎缝中的流动性 Joint Types and Flowability of Molten Filler Metal in<br>the Clearance .....                                                        | 17 |
| 1.6.2 加热方法 Methods for Heating .....                                                                                                                       | 18 |
| 1.6.3 工件的升温速度和冷却速度 Heating and Cooling Rate of Workpieces in Brazing<br>Process .....                                                                      | 19 |
| 1.6.4 钎焊接头的保温处理和结构的弥散 Annealing for Brazed Joints and Structure Dispersion in<br>the Fillet .....                                                          | 19 |
| 参考文献 References .....                                                                                                                                      | 20 |

## 第2章 铝及铝合金的钎焊 Chapter 2 Brazing and Soldering of Aluminum and its

|                                                                                                                   |    |
|-------------------------------------------------------------------------------------------------------------------|----|
| Alloys .....                                                                                                      | 22 |
| 2.1 概述 Introduction .....                                                                                         | 22 |
| 2.2 铝及铝合金的编号 Designations of Aluminum and its Alloys .....                                                        | 22 |
| 2.3 铝及铝合金的理化性质 The Physical and Chemical Properties of Aluminum and its Alloys .....                              | 23 |
| 2.3.1 铝及铝合金的物理性质 The Physical Properties of Aluminum and its Alloys .....                                         | 23 |
| 2.3.2 铝及铝合金的化学性质 The Chemical Properties of Aluminum and its Alloys .....                                         | 34 |
| 2.4 铝氧化膜的本质及其在加热时的变化 The Nature of Oxide Film on Aluminum and its Change during Heating .....                     | 35 |
| 2.5 铝钎剂 Flux for Aluminum Brazing and Soldering .....                                                             | 36 |
| 2.5.1 铝的硬钎剂 Fluxes for Aluminum Brazing .....                                                                     | 36 |
| 2.5.2 铝的软钎剂 Fluxes for Aluminum Soldering .....                                                                   | 46 |
| 2.6 钎焊时铝氧化膜的脱除机制 Removal Mechanism of Oxide Film on Aluminum during Brazing .....                                 | 49 |
| 2.6.1 铝氧化膜与熔盐钎剂的相互作用 Interaction of Oxide Film on Aluminum with Molten Salt Flux .....                            | 49 |
| 2.6.2 真空环境下金属蒸气对铝氧化膜的破坏 Disruption of Oxide Film on Aluminum by Metal Vapor in Vacuum Environment .....           | 51 |
| 2.7 铝钎料 Brazing Filler Metals and Solders for Aluminum Alloys .....                                               | 51 |
| 2.7.1 Al-Si 系钎料 (液相线温度范围 570 ~ 630°C) Filler Metals of Al-Si Series (melting range 570 ~ 630°C) .....             | 52 |
| 2.7.2 Al-Si-Cu-Zn 系钎料 (液相线温度范围 500 ~ 577°C) Filler Metals of Al-Si-Cu-Zn Series (melting range 500 ~ 577°C) ..... | 53 |
| 2.7.3 Al-Cu-Ag-Zn 系钎料 (液相线温度范围 400 ~ 500°C) Filler Metals of Al-Cu-Ag-Zn Series (melting range 400 ~ 500°C) ..... | 54 |
| 2.7.4 Al-Ge-Si 系钎料 (液相线温度范围 425 ~ 500°C) Filler Metals of Al-Ge-Si Series (melting range 425 ~ 500°C) .....       | 55 |
| 2.7.5 Zn-Al 系钎料 (液相线温度范围 382 ~ 400°C) Solders of Zn-Al Series (melting range 382 ~ 400°C) .....                   | 56 |
| 2.7.6 Cd-Zn 系钎料 (液相线温度范围 265 ~ 350°C) Solders of Cd-Zn Series (melting range 265 ~ 350°C) .....                   | 57 |
| 2.7.7 Sn-Zn 系钎料 (液相线温度范围 198 ~ 260°C) Solders of Sn-Zn Series (melting range 198 ~ 260°C) .....                   | 58 |
| 2.7.8 Sn-Pb 系钎料 (液相线温度范围 183 ~ 270°C) Solders of Sn-Pb Series (melting range 183 ~ 270°C) .....                   | 58 |
| 2.7.9 Pb-Bi 系钎料 (液相线温度范围 124 ~ 200°C) Solders of Pb-Bi Series (melting range 124 ~ 200°C) .....                   | 60 |
| 2.8 铝的复合钎焊材料 The Composite Materials for Aluminum Brazing or Soldering .....                                      | 60 |
| 2.8.1 铝钎焊板 Aluminum Brazing Sheets .....                                                                          | 60 |
| 2.8.2 药芯铝钎焊丝 Flux Cored Filler Metal Wires for Aluminum Brazing or Soldering .....                                | 61 |
| 2.8.3 铝钎焊膏 Aluminum Brazing Paste .....                                                                           | 61 |
| 2.8.4 其他 The Others .....                                                                                         | 62 |
| 2.9 铝钎焊中的一些特殊技艺 Some Special Skills in Aluminum Brazing and Soldering .....                                       | 62 |
| 2.9.1 用金属镓来作为界面活性剂进行铝合金零件的精密扩散钎焊 Gallium Used as a Surfactant for Precise Soldering of Aluminum Alloy Parts ..... | 62 |

|                                                                                                                              |           |
|------------------------------------------------------------------------------------------------------------------------------|-----------|
| 2.9.2 用锗粉进行铝合金的无钎剂扩散钎焊 Fluxless Diffusion Brazing of Aluminum Alloys with Germanium Powder .....                             | 62        |
| 2.9.3 铝及铝合金的表面软钎焊钎涂改性 Surface Modification of Aluminum Alloys by Solde-coating .....                                         | 62        |
| 2.9.4 铝的自钎软钎剂 Self-soldering Flux Used for Soldering Aluminum Alloy Parts .....                                              | 63        |
| 2.9.5 铝合金面上敷以 Nocolok 钎剂-硅粉-合成树脂复合涂层 A Composite Coating on Aluminum Alloys Made by Resinized Silicon and Nocolok Flux ..... | 63        |
| 2.10 铝钎焊的焊前准备和焊后处理 Pre-brazing Preparations and Post-brazing Operations .....                                                | 64        |
| 2.10.1 接头和夹具的设计 Joint and Jig Design .....                                                                                   | 64        |
| 2.10.2 工件的预清洗 Pre-cleaning of Workpieces to be Brazed .....                                                                  | 66        |
| 2.10.3 工件焊后的清洗 Post-braze Cleaning of Workpieces .....                                                                       | 68        |
| 2.10.4 镀覆 Finishing .....                                                                                                    | 69        |
| 参考文献 References .....                                                                                                        | 70        |
| <b>第3章 铜和铜合金的钎焊 Chapter 3 Brazing and Soldering of Copper and Copper Alloys .....</b>                                        | <b>74</b> |
| 3.1 概述 Introduction .....                                                                                                    | 74        |
| 3.2 钎焊性 Brazability and Solderability .....                                                                                  | 77        |
| 3.2.1 纯铜 Copper .....                                                                                                        | 77        |
| 3.2.2 普通黄铜 Brasses .....                                                                                                     | 77        |
| 3.2.3 锡黄铜 Tin Brasses .....                                                                                                  | 77        |
| 3.2.4 铅黄铜 Leaded Brasses .....                                                                                               | 77        |
| 3.2.5 锰黄铜 Manganese Brasses .....                                                                                            | 77        |
| 3.2.6 锡青铜 Tin Bronzes .....                                                                                                  | 77        |
| 3.2.7 铝青铜 Aluminum Bronzes .....                                                                                             | 77        |
| 3.2.8 铍青铜 Beryllium Bronzes .....                                                                                            | 78        |
| 3.2.9 硅青铜 Silicon Bronzes .....                                                                                              | 78        |
| 3.2.10 铬青铜和镉青铜 Chromium Bronzes and Cadmium Bronzes .....                                                                    | 78        |
| 3.2.11 锌白铜和锰白铜 Copper-nickel Alloys .....                                                                                    | 78        |
| 3.3 软钎料 Solders .....                                                                                                        | 78        |
| 3.3.1 锡钎料 Tin Base Solders .....                                                                                             | 78        |
| 3.3.2 铅钎料 Lead Base Solders .....                                                                                            | 81        |
| 3.3.3 镉钎料 Cadmium Base Solders .....                                                                                         | 81        |
| 3.3.4 无铅钎料 Lead Free Solders .....                                                                                           | 83        |
| 3.4 硬钎料 Brazing Filler Metals .....                                                                                          | 90        |
| 3.4.1 对钎料的基本要求 Demands on Brazing Filler Metals .....                                                                        | 90        |
| 3.4.2 钎料的分类 Classification of Brazing Filler Metals .....                                                                    | 90        |
| 3.4.3 钎料的型号与牌号 Designations of Brazing Filler Metals .....                                                                   | 91        |
| 3.4.4 银钎料 Silver Base Filler Metals .....                                                                                    | 91        |
| 3.4.5 低银钎料 Low Silver Base Filler Metals .....                                                                               | 101       |
| 3.4.6 铜磷钎料 Copper-phosphorus Filler Metals .....                                                                             | 108       |
| 3.5 钎剂 Fluxes .....                                                                                                          | 112       |
| 3.5.1 钎剂的功能 Functions of Brazing Fluxes .....                                                                                | 112       |
| 3.5.2 对钎剂的基本要求 Demands on Brazing Fluxes .....                                                                               | 112       |
| 3.5.3 钎剂的分类及型号 Classification and Type of Fluxes .....                                                                       | 113       |

|                                                                                                                      |            |
|----------------------------------------------------------------------------------------------------------------------|------------|
| 3.6 软钎剂 Soldering Fluxes .....                                                                                       | 113        |
| 3.6.1 腐蚀性钎剂 Corrosive Fluxes .....                                                                                   | 114        |
| 3.6.2 弱腐蚀性钎剂 Medial Corrosive Fluxes .....                                                                           | 115        |
| 3.6.3 无腐蚀性钎剂 Non-corrosive Fluxes .....                                                                              | 116        |
| 3.7 硬钎剂 Brazing Fluxes .....                                                                                         | 117        |
| 3.8 表面准备 Surface Preparation .....                                                                                   | 120        |
| 3.9 接头设计 Joint Design .....                                                                                          | 120        |
| 3.10 钎焊方法和工艺 Methods and Technology of Soldering and Brazing .....                                                   | 121        |
| 3.10.1 铜 Copper .....                                                                                                | 121        |
| 3.10.2 黄铜 Brasses .....                                                                                              | 121        |
| 3.10.3 铜和黄铜软钎焊接头强度 The Strength of Copper and Brass Solded Joints .....                                              | 121        |
| 3.10.4 锰黄铜 Manganese Brasses .....                                                                                   | 124        |
| 3.10.5 铍青铜 Beryllium Bronzes .....                                                                                   | 125        |
| 3.10.6 铬青铜 Chromium Bronzes .....                                                                                    | 125        |
| 3.10.7 镉青铜和锡青铜 Cadmium Bronzes and Tin Bronzes .....                                                                 | 125        |
| 3.10.8 硅青铜 Silicon Bronzes .....                                                                                     | 125        |
| 3.10.9 铝青铜 Aluminum Bronzes .....                                                                                    | 125        |
| 3.10.10 锌白铜和锰白铜 Copper-nickel Alloys .....                                                                           | 126        |
| 参考文献 References .....                                                                                                | 126        |
| <b>第4章 电子工业中的软钎焊 Chapter 4 Soldering in Electronic Industry .....</b>                                                | <b>128</b> |
| 4.1 电子制造与软钎焊 Electronic Manufacture and Soldering .....                                                              | 128        |
| 4.1.1 软钎焊在电子工业中的地位 The Position of Soldering Technique in Electronic Industry .....                                  | 128        |
| 4.1.2 电子制造与电子封装 Electronic Manufacture and Electronic Packaging .....                                                | 128        |
| 4.1.3 电子工业中钎焊连接的特点及发展历程 The Characteristic and Developemt Course of Soldering Technique in Electronic Industry ..... | 130        |
| 4.2 软钎焊连接的基本原理 Fundamental of Soldering .....                                                                        | 131        |
| 4.2.1 软钎焊的定义 Definition of Soldering .....                                                                           | 131        |
| 4.2.2 钎料与母材间的相互作用 Interaction Between Solder and Base Metal .....                                                    | 131        |
| 4.2.3 软钎焊性 Solderability .....                                                                                       | 136        |
| 4.2.4 影响电子元器件软钎焊性的因素 Influence Factors on Solderability of Electronic Components .....                               | 137        |
| 4.2.5 钎焊性的测试与评价 Solderability Testing and Evaluation .....                                                           | 137        |
| 4.3 软钎料合金 Solder Alloys .....                                                                                        | 139        |
| 4.3.1 锡铅钎料 Tin-lead Solders .....                                                                                    | 139        |
| 4.3.2 无铅钎料 Lead-free Solders .....                                                                                   | 143        |
| 4.4 软钎剂 Soldering Fluxes .....                                                                                       | 146        |
| 4.4.1 软钎剂反应原理 Fundamental of the Reaction of Soldering Flux .....                                                    | 146        |
| 4.4.2 软钎剂的分类 Classification of Soldering Flux .....                                                                  | 147        |
| 4.4.3 软钎剂的组成 Composition of Soldering Flux .....                                                                     | 148        |
| 4.5 钎料膏与药芯软钎焊丝 Solder Paste and Flux-cored Solder Wire .....                                                         | 150        |
| 4.5.1 钎料膏的分类 Classification of Solder Paste .....                                                                    | 150        |
| 4.5.2 钎料膏的组成 Composition of Solder Paste .....                                                                       | 151        |
| 4.5.3 典型焊膏配方 Typical Compositions of Soldering Paste .....                                                           | 153        |
| 4.5.4 钎料膏的性能 Properties of Solder Paste .....                                                                        | 153        |

|                                                                                          |            |
|------------------------------------------------------------------------------------------|------------|
| 4.5.5 钎料膏的选用 Selection of Solder Paste .....                                             | 154        |
| 4.5.6 药芯软钎焊丝 Flux-cored Solder Wire .....                                                | 155        |
| 4.6 电子组装技术 Electronic Assembling Technology .....                                        | 155        |
| 4.6.1 电子组装概述 Introduction of Electronic Assembly .....                                   | 155        |
| 4.6.2 印刷技术 Solder Paste Print .....                                                      | 159        |
| 4.6.3 贴片技术 Pick and Place .....                                                          | 164        |
| 4.6.4 再流焊 Reflow .....                                                                   | 164        |
| 4.6.5 波峰焊 Wave Soldering .....                                                           | 166        |
| 4.6.6 返修技术 Rework .....                                                                  | 170        |
| 4.6.7 选择性焊接技术 Selective Soldering .....                                                  | 171        |
| 4.6.8 通孔回流焊接技术 Through-hole Reflow .....                                                 | 174        |
| 4.7 倒装芯片技术 Flip-chip .....                                                               | 175        |
| 4.7.1 倒装芯片简介 Introduction of Flip-chip .....                                             | 175        |
| 4.7.2 软钎料凸点 Solder Bump .....                                                            | 175        |
| 4.7.3 倒装焊工艺 Flip-chip .....                                                              | 179        |
| 参考文献 References .....                                                                    | 181        |
| <b>第5章 碳钢、铸铁的钎焊 Chapter 5 Brazing and Soldering of Carbon Steels and Cast Iron .....</b> | <b>182</b> |
| 5.1 碳钢的钎焊性 Brazability and Solderability of Carbon Steels .....                          | 182        |
| 5.2 碳钢的表面清理 Surface Preparation of Steels .....                                          | 182        |
| 5.3 碳钢的软钎焊 Soldering of Steels .....                                                     | 182        |
| 5.4 碳钢的硬钎焊 Brazing of Steels .....                                                       | 183        |
| 5.4.1 还原性气氛 Reduction Atmospheres .....                                                  | 183        |
| 5.4.2 惰性气体 Inert Gas .....                                                               | 186        |
| 5.4.3 真空 Vacuum .....                                                                    | 186        |
| 5.5 钎焊工艺 Technology of Brazing .....                                                     | 188        |
| 5.5.1 铜钎料 Copper Filler Metals .....                                                     | 188        |
| 5.5.2 铜锡钎料 Copper-tin Filler Metals .....                                                | 189        |
| 5.5.3 黄铜钎料 Brass Filler Metals .....                                                     | 190        |
| 5.5.4 银钎料 Silver Filler Metals .....                                                     | 191        |
| 5.5.5 钎焊接头强度 Strength of Brazed Joints .....                                             | 192        |
| 5.6 铸铁的钎焊 Brazing of Cast Iron .....                                                     | 194        |
| 5.6.1 概述 Introduction .....                                                              | 194        |
| 5.6.2 铸铁的钎焊性 Brazability of Cast Iron .....                                              | 194        |
| 5.6.3 钎焊工艺 Technology of Brazing .....                                                   | 194        |
| 参考文献 References .....                                                                    | 196        |
| <b>第6章 不锈钢的钎焊 Chapter 6 Brazing and Soldering of Stainless Steels .....</b>              | <b>197</b> |
| 6.1 概述 Introduction .....                                                                | 197        |
| 6.2 不锈钢的钎焊性 Brazability and Solderability of Stainless Steels .....                      | 197        |
| 6.3 表面准备 Surface Preparation .....                                                       | 204        |
| 6.4 不锈钢的软钎焊 Soldering of Stainless Steels .....                                          | 205        |
| 6.5 不锈钢的硬钎焊 Brazing of Stainless Steels .....                                            | 205        |
| 6.5.1 银钎料 Silver Base Filler Metals .....                                                | 205        |
| 6.5.2 高温铜钎料 High Temperature Copper Base Filler Metals .....                             | 206        |

|                                                                                                                                           |            |
|-------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 6.5.3 锰钎料 Manganese Filler Metals .....                                                                                                   | 208        |
| 6.5.4 镍钎料 Nickel Filler Metals .....                                                                                                      | 209        |
| 6.5.5 非晶态镍钎料 Amorphous Nickel-base Filler Metals .....                                                                                    | 217        |
| 6.5.6 金钎料 Gold-base Filler Metals .....                                                                                                   | 218        |
| 6.5.7 含钯钎料 Palladium-bearing Filler Metals .....                                                                                          | 221        |
| 6.5.8 硬钎剂 Brazing Fluxes .....                                                                                                            | 222        |
| 6.5.9 硬钎焊工艺 Technology for Brazing of Stainless Steels .....                                                                              | 222        |
| 参考文献 References .....                                                                                                                     | 234        |
| <b>第7章 高温合金的钎焊 Chapter 7 Brazing of High Temperature Alloys .....</b>                                                                     | <b>235</b> |
| 7.1 概述 Introduction .....                                                                                                                 | 235        |
| 7.2 钎焊性 Brazability .....                                                                                                                 | 243        |
| 7.3 钎料 Brazing Filler Metals .....                                                                                                        | 243        |
| 7.3.1 银钎料 Silver Filler Metals .....                                                                                                      | 244        |
| 7.3.2 纯铜钎料 Pure Copper Used as Filler Metal .....                                                                                         | 244        |
| 7.3.3 镍钎料 Nickel Filler Metals .....                                                                                                      | 244        |
| 7.3.4 活性扩散钎焊钎料 Activated Diffusion Brazing Filler Metals .....                                                                            | 245        |
| 7.4 钎焊工艺 Brazing Technology of High Temperature Alloys .....                                                                              | 246        |
| 7.5 TD-Ni 的钎焊 Brazing of TD-Ni .....                                                                                                      | 255        |
| 7.6 瞬态液相连接 Transient Liquid Phase Bonding .....                                                                                           | 256        |
| 7.6.1 瞬态液相连接的过程 Transient Liquid Phase Bonding Process .....                                                                              | 256        |
| 7.6.2 瞬态液相连接的参数 Parameters of the Transient Liquid Phase Bonding .....                                                                    | 256        |
| 7.7 大间隙钎焊 Wide-gap Brazing .....                                                                                                          | 260        |
| 7.7.1 混合粉末法 Brazing with Mixed Powders .....                                                                                              | 260        |
| 7.7.2 预填高熔点粉末法 Preplacement with High Melting Point Powders .....                                                                         | 262        |
| 参考文献 References .....                                                                                                                     | 265        |
| <b>第8章 钨、钼、钽、铌的钎焊 Chapter 8 Brazing of Tungsten, Molybdenum, Tantalum and Niobium .....</b>                                               | <b>267</b> |
| 8.1 概述 Introduction .....                                                                                                                 | 267        |
| 8.2 钨、钼、钽、铌及其合金的物理、化学及力学性能 Physical, Chemical and Mechanical Properties of Tungsten, Molybdenum, Tantalum, Niobium and their Alloys ..... | 267        |
| 8.2.1 钨、钼、钽、铌及其合金的物理及力学性能 Physical and Mechanical Properties of Tungsten, Molybdenum, Tantalum, Niobium and their Alloys .....            | 267        |
| 8.2.2 钨、钼、钽、铌的化学性能 Chemical Properties of Tungsten, Molybdenum, Tantalum and Niobium .....                                                | 268        |
| 8.2.3 钨、钼、钽、铌及其合金牌号与性能 Designations and Properties of Tungsten, Molybdenum, Tantalum, Niobium and their Alloys .....                      | 269        |
| 8.3 钨、钼、钽、铌的钎焊工艺 Brazing Technology for Tungsten, Molybdenum, Tantalum and Niobium .....                                                  | 274        |
| 8.3.1 钨、钼、钽、铌钎焊前准备 Surface Preparation for Brazing Tungsten, Molybdenum, Tantalum and Niobium .....                                       | 274        |
| 8.3.2 钨、钼及其合金的钎焊 Brazing of Tungsten, Molybdenum and their Alloys .....                                                                   | 274        |
| 8.3.3 钽、铌及其合金的钎焊 Brazing of Tungsten, Niobium and their Alloys .....                                                                      | 276        |
| 8.4 钨、钼、钽、铌钎焊接头的应用 Brazed Joints of Tungsten, Molybdenum, Tantalum and Niobium in Application .....                                       | 276        |

|                                                                                                                        |            |
|------------------------------------------------------------------------------------------------------------------------|------------|
| 参考文献 References .....                                                                                                  | 277        |
| <b>第9章 钛、锆及其合金的钎焊 Chapter 9 Brazing of Titanium, Zirconium and Their Alloys .....</b>                                  | <b>278</b> |
| 9.1 概述 Introduction .....                                                                                              | 278        |
| 9.2 钛、锆及其合金的理化特性及分类 Physical and Chemical Properties and Classifications of Titanium, Zirconium and their Alloys ..... | 278        |
| 9.2.1 钛及其合金的理化特性及分类 Physical, Chemical Properties and Classifications of Titanium and its Alloys .....                 | 278        |
| 9.2.2 锆及其合金的理化特性及分类 Physical and Chemical Properties and Classifications of Zirconium and its Alloys .....             | 280        |
| 9.3 钛、锆及其合金钎焊特点 Brazing Characteristics of Titanium, Zirconium and their Alloys .....                                  | 281        |
| 9.4 钎料 Filler Metals .....                                                                                             | 282        |
| 9.4.1 钛及其合金用钎料 Filler Metals for Brazing Titanium and its Alloys .....                                                 | 282        |
| 9.4.2 锆及其合金钎焊用钎料 Filler Metals for Brazing Zirconium and its Alloys .....                                              | 292        |
| 9.5 钎焊方法和设备 Brazing Methods and Equipments .....                                                                       | 293        |
| 9.6 钎焊前清理和表面准备 Cleaning and Surface Preparation for Workpiece to be Brazed .....                                       | 293        |
| 9.7 钎剂和保护气氛 Fluxes and Protective Atmospheres .....                                                                    | 294        |
| 9.8 钛合金与其他材料的钎焊 Brazing of Titanium Alloys to other Materials .....                                                    | 294        |
| 9.8.1 钛与铝的钎焊 Brazing Titanium to Aluminum .....                                                                        | 294        |
| 9.8.2 钛与不锈钢的钎焊 Brazing Titanium to Stainless Steel .....                                                               | 295        |
| 9.8.3 钛与铜的钎焊 Brazing Titanium to Copper .....                                                                          | 296        |
| 9.8.4 钛与铍的钎焊 Brazing Titanium to Beryllium .....                                                                       | 296        |
| 9.8.5 钛与陶瓷的钎焊 Brazing Titanium to Ceramics .....                                                                       | 296        |
| 9.9 钛合金钎焊技术的发展 Developments in Brazing Technique of Titanium Alloys .....                                              | 297        |
| 9.9.1 焊接钎焊 Weld-brazing .....                                                                                          | 297        |
| 9.9.2 瞬间液相扩散焊 Transient Liquid Phase Diffusion Bonding .....                                                           | 298        |
| 9.9.3 液相界面扩散焊 Liquid Interface Diffusion Bonding .....                                                                 | 298        |
| 9.10 应用 Applications .....                                                                                             | 303        |
| 9.10.1 钛及钛合金钎焊的应用 Applications of Brazing Titanium and its Alloys .....                                                | 303        |
| 9.10.2 锆及锆合金钎焊的应用 Applications of Brazing Zirconium and its Alloys .....                                               | 306        |
| 参考文献 References .....                                                                                                  | 306        |
| <b>第10章 铍、镁合金的钎焊 Chapter 10 Brazing of Beryllium, Magnesium Alloys .....</b>                                           | <b>309</b> |
| 10.1 铍的钎焊 Brazing of Beryllium .....                                                                                   | 309        |
| 10.1.1 铍的钎焊性 Brazability of Beryllium .....                                                                            | 309        |
| 10.1.2 铍的表面准备 Precleaning and Surface Preparation of Beryllium .....                                                   | 310        |
| 10.1.3 钎焊铍用钎料 Filler Metals for Brazing Beryllium .....                                                                | 311        |
| 10.1.4 钎剂和气氛 Fluxes and Atmosphere .....                                                                               | 313        |
| 10.1.5 铍的钎焊工艺 Brazing procedures of Beryllium .....                                                                    | 313        |
| 10.1.6 铍钎焊时应注意的问题 Notes on Brazing of Beryllium .....                                                                  | 314        |
| 10.1.7 铍钎焊的应用 Applications .....                                                                                       | 315        |
| 10.2 镁和镁合金的钎焊 Brazing of Magnesium and its Alloys .....                                                                | 315        |
| 10.2.1 镁合金的钎焊性 Brazability of Magnesium Alloys .....                                                                   | 316        |

|                       |                                                                                |            |
|-----------------------|--------------------------------------------------------------------------------|------------|
| 10.2.2 镁合金钎焊用钎料       | Brazing Alloys for Magnesium Alloys                                            | 316        |
| 10.2.3 镁合金用钎剂         | Fluxes for Brazing Magnesium Alloys                                            | 318        |
| 10.2.4 钎焊前表面清理        | Surface Cleaning before Brazing                                                | 318        |
| 10.2.5 镁合金的钎焊过程       | Brazing Processes of Magnesium Alloys                                          | 319        |
| 10.2.6 焊后清洗           | Postcleaning                                                                   | 320        |
| 参考文献                  | References                                                                     | 320        |
| <b>第 11 章 硬质合金的钎焊</b> | <b>Chapter 11 Brazing of Carbides</b>                                          | <b>321</b> |
| 11.1 概述               | Introduction                                                                   | 321        |
| 11.1.1 硬质合金的分类        | Classification of Carbides                                                     | 321        |
| 11.1.2 硬质合金的性能和用途     | Properties and Applications of Carbides                                        | 322        |
| 11.1.3 硬质合金的冶金特性      | The Metallurgical Characteristics of Carbides                                  | 328        |
| 11.2 硬质合金工具的钎焊        | Brazing of Carbide Tools                                                       | 329        |
| 11.2.1 硬质合金工具基体材料的选择  | Selection of Substrate for Carbide Tools                                       | 329        |
| 11.2.2 硬质合金工具钎缝的设计    | Design of Joint for Carbide Tools                                              | 330        |
| 11.2.3 硬质合金工具钎缝的力学性能  | Mechanical Properties of Brazed Joint in Carbide Tools                         | 331        |
| 11.3 硬质合金的钎焊性         | The Brazability of Carbides                                                    | 331        |
| 11.3.1 硬质合金的钎焊润湿性     | The Brazing Wettability of Carbides                                            | 331        |
| 11.3.2 硬质合金的钎焊内应力     | The Inner Stress of Carbides after Brazing                                     | 332        |
| 11.4 钎料与钎剂            | The Filler Metals and Fluxes                                                   | 332        |
| 11.4.1 硬质合金钎焊常用钎料     | The Conventional Filler Metals Used for Brazing Cemented Carbides              | 332        |
| 11.4.2 钎料性能的比较        | Property Comparison among Some Filler Metals                                   | 332        |
| 11.4.3 选择钎料的方法        | Selection of Filler Metals                                                     | 334        |
| 11.4.4 硬质合金钎焊用钎剂      | Fluxes for Brazing Carbides                                                    | 335        |
| 11.5 硬质合金钎焊工艺         | Technique for Brazing Carbides                                                 | 335        |
| 11.5.1 硬质合金工具常用钎焊方法   | Usual Methods for Brazing Carbide Tools                                        | 335        |
| 11.5.2 钎焊工艺过程及工艺参数确定  | The Brazing Technical Process and the Selection of Technical Parameters        | 335        |
| 11.5.3 零件装配、定位与钎料添加   | Assembling and Fixing of Accessories, Feed of Filler Metals                    | 336        |
| 11.5.4 钎焊的预处理及焊后处理    | Pre-treatment and Post-treatment of Brazing                                    | 337        |
| 11.5.5 钎焊工艺规程内容       | Brazing Technical Regulations                                                  | 337        |
| 11.6 钎焊裂纹的产生机理与预防措施   | The Formation Mechanism of Brazing Crack and Preventing Measures               | 338        |
| 11.6.1 工具结构引发的裂纹      | Crack Caused from Tool Structure                                               | 338        |
| 11.6.2 热应力引发的裂纹       | Crack Caused from Thermal Stress                                               | 338        |
| 11.6.3 力学性能差异引发的裂纹    | Crack Caused from Difference of Mechanical Properties                          | 339        |
| 11.6.4 前后处理导致的裂纹      | Crack Caused from Pre-treatment and Post-treatment                             | 339        |
| 11.6.5 预防钎焊裂纹的措施      | Preventing Measures for Brazing Cracks                                         | 339        |
| 11.7 防止脱焊及提高钎缝强度的措施   | Measures for Preventing Brazing Failure and Improving Strength of Brazed Joint | 340        |
| 11.7.1 硬质合金脱焊的原因      | Failure Causes during Brazing Carbides                                         | 340        |
| 11.7.2 提高钎缝强度的设计方法    | Designing Methods for Improving the Strength of Brazed Joint                   | 340        |

|             |                  |                                                                                  |            |
|-------------|------------------|----------------------------------------------------------------------------------|------------|
| 11.7.3      | 提高钎缝强度的工艺方法      | Technical Methods for Improving the Strength of Brazed Joint                     | 341        |
| 11.7.4      | 提高钎缝强度的钎焊材料      | Filler Metals for Enhancing the Strength of Brazed Joint                         | 342        |
| 11.8        | 硬质合金工具钎焊实例       | Examples of Brazing Carbide Tools                                                | 342        |
| 11.8.1      | 金属切削刀具的钎焊        | Brazing of Metal Cutting Tools                                                   | 342        |
| 11.8.2      | 非金属切削工具的钎焊       | Brazing of Non-metal Cutting Tools                                               | 346        |
| 11.8.3      | 硬质合金模具的钎焊        | Brazing of Carbide Dies                                                          | 346        |
| 11.8.4      | 测量器具硬质合金的钎焊      | Brazing of Carbides in Measuring Instruments                                     | 346        |
| 11.8.5      | 矿用采掘工具的钎焊        | Brazing of Excavating Tools Used in Mining                                       | 347        |
| 11.8.6      | 破碎工具的钎焊          | Brazing of Fragmentation Tools                                                   | 347        |
| 11.8.7      | 硬质合金钎具的钎焊        | Brazing of Carbide Used in Rock Bit Drill                                        | 348        |
|             | 参考文献             | References                                                                       | 351        |
| <b>第12章</b> | <b>金刚石工具的钎焊</b>  | <b>Chapter 12 Brazing of Diamond Tools</b>                                       | <b>352</b> |
| 12.1        | 概述               | Introduction                                                                     | 352        |
| 12.1.1      | 金刚石及其分类          | Diamond and its Classification                                                   | 352        |
| 12.1.2      | 金刚石的性能和用途        | Properties and Applications of Diamond                                           | 354        |
| 12.1.3      | 常用金刚石工具简介        | A Brief Introduction of Usual Diamond Tools                                      | 355        |
| 12.1.4      | 金刚石及金刚石工具的钎焊性    | The Brazability of Diamond and Diamond Tools                                     | 356        |
| 12.2        | 金刚石工具的钎焊特点       | The Brazing Characteristics of Diamond Tools                                     | 357        |
| 12.2.1      | 金刚石工具的钎焊方法       | The Brazing Methods for Diamond Tools                                            | 357        |
| 12.2.2      | 金刚石工具的钎焊温度       | The Brazing Temperature of Diamond Tools                                         | 357        |
| 12.2.3      | 金刚石工具的钎缝强度       | The Strength of Brazed Joints in Diamond Tools                                   | 358        |
| 12.2.4      | 单晶金刚石及单层金刚石工具的钎焊 | Brazing of Single Crystal Diamond and Single Layer Diamond Tools                 | 360        |
| 12.2.5      | PCD 和 PDC 的钎焊    | Brazing of PCD and PDC                                                           | 361        |
| 12.2.6      | PCBN 工具的钎焊       | Brazing of PCBN Tools                                                            | 361        |
| 12.2.7      | 金刚石工具的钎焊工艺过程     | Brazing Technical Process of Diamond Tools                                       | 362        |
| 12.3        | 钎料与钎剂            | The Filler Metals and Fluxes                                                     | 362        |
| 12.3.1      | 金刚石工具钎焊用钎料       | The Filler Metals Used for Brazing Diamond Tools                                 | 363        |
| 12.3.2      | 钎料性能比较           | Property Comparison among the Filler Metals                                      | 363        |
| 12.3.3      | 钎料的合理选择          | Rational Choice of the Filler Metals                                             | 365        |
| 12.3.4      | 钎剂的合理配用          | Rational Match of the Fluxes                                                     | 365        |
| 12.3.5      | 金刚石单晶和石墨用钎料      | Filler Metals Used for Brazing Single Crystal Diamond and Graphite               | 366        |
| 12.4        | 金刚石工具脱焊的机理及应对措施  | The Failure Mechanism in Brazing Diamond Tools along with its Improving Measures | 367        |
| 12.4.1      | 钎料强度与脱焊          | Strength of Filler Metal and Brazing Failure                                     | 367        |
| 12.4.2      | 胎体成分与脱焊          | The Composition of Inlay in Cutting-tip along with Brazing Failure               | 368        |
| 12.4.3      | 钎焊工艺与脱焊          | Brazing Technique and Brazing Failure                                            | 368        |
| 12.4.4      | 工况条件与脱焊          | Working Condition with Brazing Failure                                           | 368        |
| 12.4.5      | 避免脱焊的措施          | Measures for Preventing Brazing Failure                                          | 368        |
| 12.5        | 金刚石的热稳定性         | Thermal Stability of Diamond                                                     | 369        |
| 12.5.1      | 金刚石的热稳定性         | Thermal Stability of Diamond                                                     | 369        |

|                             |                        |                                                                           |                                                                            |
|-----------------------------|------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------|
| 12.5.2                      | 包裹体与热稳定性               | The Influence of Impurities on the Thermal Stability of Diamond           | 369                                                                        |
| 12.5.3                      | 钎焊过程对金刚石性能的影响          | Influence of Brazing Process on the Property of Diamond                   | 370                                                                        |
| 12.6                        | 粉状钎料在金刚石工具中的作用         | The Role of Powder Filler Metal in Brazing Diamond Tools                  | 370                                                                        |
| 12.6.1                      | 胎体对金刚石的把持机理            | Fixation of Powder Metals in Inlay on Diamond                             | 370                                                                        |
| 12.6.2                      | 活性元素对金刚石与胎体结合的影响       | Effect of Active Elements on the Bonding of Diamond with Inlay            | 371                                                                        |
| 12.6.3                      | 粉状钎料形式的预合金粉末           | Pre-alloyed Powder Used as Powder Filler Metal                            | 371                                                                        |
| 12.6.4                      | 粉状钎料对金刚石的把持力           | The Fixing Strength of Powder Filler Metal on Diamond in Inlay            | 372                                                                        |
| 12.6.5                      | 粉状钎料提高金刚石工具的使用寿命       | Powder Filler Metals Enhance the Service Life of Diamond Tools            | 372                                                                        |
| 12.6.6                      | 粉状钎料提高金刚石工具的锋利度        | Powder Filler Metals Improve Tartness (sharpness) of Diamond Tools        | 373                                                                        |
| 12.7                        | 金刚石工具的钎焊举例             | Examples of Brazing Diamond Tools                                         | 374                                                                        |
| 12.7.1                      | 热压型石材加工用金刚石锯片的自动感应钎焊   | Auto-induction Brazing of Diamond Saw for Cutting Thermal Pressed Stone   | 374                                                                        |
| 12.7.2                      | 烧结型金刚石薄壁钻的感应钎焊         | Induction Brazing of Cemented Thin-wall Diamond Drills                    | 374                                                                        |
| 12.7.3                      | 地质类金刚石钻头的浸渍钎焊          | Dip Brazing of Natural Diamond Drills                                     | 374                                                                        |
| 12.7.4                      | 金属拉丝用聚晶金刚石 (PCD) 的炉中钎焊 | Furnace Brazing of PCD for Metal Wire Drawing                             | 375                                                                        |
| 12.7.5                      | 复合片 (PDC) 石油钻头的真空钎焊    | Vacuum Brazing of PDC for Petroleum Drill-tip                             | 375                                                                        |
| 12.7.6                      | 机械加工用金刚石珩磨油石的电阻钎焊      | Resistance Brazing of Diamond Grinding Bar Used for Mechanical Processing | 376                                                                        |
| 12.7.7                      | 玻璃加工用金刚石磨边轮的火焰钎焊       | Flame Brazing of Diamond Range Grinding Disc for Glass Processing         | 376                                                                        |
| 12.7.8                      | 金属切削用 PCBN 的火焰钎焊       | Flame Brazing of PCBN for Metal Cutting                                   | 376                                                                        |
| 12.8                        | 石墨及石墨的钎焊               | Graphite and its Brazing                                                  | 376                                                                        |
| 12.8.1                      | 石墨及其性质                 | Graphite and its Properties                                               | 376                                                                        |
| 12.8.2                      | 石墨的钎焊性                 | Brazability of Graphite                                                   | 377                                                                        |
| 12.8.3                      | 石墨与石墨的钎焊               | Brazing Graphite to Graphite                                              | 378                                                                        |
| 12.9                        | 石墨与其他材料的钎焊             | Brazing Graphite to other Materials                                       | 379                                                                        |
| 12.9.1                      | 石墨与钨钼的钎焊               | Brazing Graphite to Molybdenum and Tungsten                               | 379                                                                        |
| 12.9.2                      | 石墨与陶瓷的钎焊               | Brazing Graphite to Ceramics                                              | 379                                                                        |
| 12.9.3                      | 石墨与不锈钢的钎焊              | Brazing Graphite to Stainless Steel                                       | 380                                                                        |
| 12.9.4                      | 石墨与铜的钎焊                | Brazing Graphite to Copper                                                | 380                                                                        |
|                             | 参考文献                   | References                                                                | 380                                                                        |
| <b>第 13 章 半导体材料硅、砷化镓的钎焊</b> |                        |                                                                           | <b>Chapter 13 Soldering of Semiconductor Materials: Silicon and Ga, As</b> |
| 13.1                        | 概述                     | Introduction                                                              | 383                                                                        |
| 13.2                        | 半导体材料简介                | Brief Introduction of Semiconductor Materials                             | 383                                                                        |

|                                                                                                        |            |
|--------------------------------------------------------------------------------------------------------|------------|
| 13.2.1 硅的物理、化学特性 Physical and Chemical Properties of Silicon                                           | 384        |
| 13.2.2 砷化镓的物理、化学特性 Physical and Chemical Properties of GaAs                                            | 384        |
| 13.3 硅器件钎焊技术 Soldering Technique for Silicon Devices                                                   | 385        |
| 13.3.1 硅器件用钎料 Solders for Soldering Silicon Devices                                                    | 385        |
| 13.3.2 焊区金属化层的制备 Preparation of Metallization for Bonding Zone                                         | 385        |
| 13.3.3 硅器件钎焊工艺 Soldering Procedures of Silicon Devices                                                 | 387        |
| 13.4 砷化镓器件的钎焊 Soldering of GaAs-devices                                                                | 388        |
| 13.4.1 金属—半导体接触及金属化 Contacts of Metal-semiconductor and Metallization                                  | 388        |
| 13.4.2 芯片钎焊 Soldering of Chips                                                                         | 388        |
| 13.5 其他钎焊方法 Other Brazing Processes                                                                    | 391        |
| 参考文献 References                                                                                        | 391        |
| <b>第14章 陶瓷与金属的钎焊 Chapter 14 Brazing of Ceramics to Metal</b>                                           | <b>392</b> |
| 14.1 概述 Introduction                                                                                   | 392        |
| 14.2 常用陶瓷与金属的性能与特点 Characteristics of General Ceramics and Metals                                      | 393        |
| 14.2.1 常用陶瓷的性能与特点 Characteristics of General Ceramics                                                  | 393        |
| 14.2.2 与陶瓷钎焊常用金属材料性能与特点 Characteristics of Common Metal Materials<br>Brazed with Ceramics              | 396        |
| 14.3 陶瓷与金属钎焊的主要方法及其材料与工艺 Brazing Processes of Ceramics with Metals and<br>Filler Materials             | 397        |
| 14.3.1 间接钎焊法 Two-step Brazing                                                                          | 397        |
| 14.3.2 直接钎焊法 Direct Brazing                                                                            | 398        |
| 14.4 陶瓷与金属钎焊接头设计 Design of Ceramics/Metal Joints                                                       | 402        |
| 14.4.1 陶瓷与金属钎焊接头的基本形式 Basic Types of Joints                                                            | 402        |
| 14.4.2 陶瓷与金属钎焊接头设计注意事项 Notes on Design of Joints                                                       | 404        |
| 14.5 陶瓷与金属钎焊接头的质量检测 Inspections of Ceramics/Metal Brazed Joint                                         | 404        |
| 14.5.1 钎焊接头的气密性检测 Leak Test of Brazed Joint                                                            | 404        |
| 14.5.2 钎焊接头的强度测试方法 Strength Test of Brazed Joint                                                       | 405        |
| 14.6 陶瓷与金属钎焊结构应用实例 Applications of Ceramics/Metal Brazed Structure                                     | 406        |
| 14.6.1 汽车发动机增压器转子 Ceramics/Steel Turbocharger Rotors                                                   | 406        |
| 14.6.2 陶瓷/金属摇杆 Ceramic/Metal Rocker Arms                                                               | 406        |
| 14.6.3 汽车发动机陶瓷挺柱 Ceramic/Metal Composite Cam Follower                                                  | 407        |
| 14.6.4 其他电子器件中采用陶瓷与金属封接的一些实例 Applications of Ceramic/Metal<br>Sealing in Electronic Device             | 407        |
| 参考文献 References                                                                                        | 408        |
| <b>第15章 真空电子器件常用金属的钎焊 Chapter 15 Brazing of Conventional<br/>Metals for Vacuum Electronic Devices</b>  | <b>410</b> |
| 15.1 概述 Introduction                                                                                   | 410        |
| 15.2 真空电子器件钎焊常用金属和钎料 Conventional Metals and Filler Metals for Brazing<br>in Vacuum Electronic Devices | 410        |
| 15.2.1 金属与合金 Metals and Alloys                                                                         | 410        |
| 15.2.2 钎料 Brazing Filler Metals                                                                        | 413        |
| 15.3 钎焊工艺技术 Brazing Techniques                                                                         | 416        |
| 15.3.1 金属零件的焊前处理 Pre-brazing Treatment of Metallic Parts                                               | 416        |
| 15.3.2 钎焊方法与工艺规范 Brazing Processes and Operating Parameters                                            | 417        |