锡化学分析方法

第11部分：铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍和钴含量的测定

电感耦合等离子体原子发射光谱法

**编 制 说 明**

（送审稿）

国标（北京）检验认证 有限公司

2023年2月

一、工作简况

1、任务来源

2021年8月，国家标准化管理委员会下达了《2021年第二批推荐性国家标准计划及相关标准外文版计划的通知》-国标委发﹝2021﹞23号文件，其中GB/T 3260系列方法之一的《锡化学分析方法 第 12 部分：铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴含量的测定 电感耦合等离子体原子发射光谱法》的制定工作由国标（北京）检验认证有限公司负责起草，项目计划编号为20213147-T-610，项目周期24个月，2023年8月前完成。

由于本项目为早于20220742-T-610《锡化学分析方法 第11部分：银、镍、钴含量的测定 火焰原子吸收光谱法》下达计划并完成，因此本文件名称修改为《锡化学分析方法 第 11部分：铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴含量的测定 电感耦合等离子体原子发射光谱法》。

2、项目编制组单位及变化情况

根据2021年10月在常州召开的任务落实会议，会上确定编制组成员共18家单位，其中一验单位7家，二验单位10家，详见见表1。

表1 编制组成员列表

|  |  |  |
| --- | --- | --- |
| 起草单位 | 一验单位 | 二验单位 |
| 国标（北京）检验认证有限公司 | 云南锡业股份有限公司锡业分公司、柳州华锡有色设计研究院有限责任公司、深圳市中金岭南有色金属股份有限公司、国合通用（青岛）测试评价有限公司、中国检验认证集团广西有限公司、昆明冶金研究院有限公司、阜阳市产品质量监督检验所 | 中国有色桂林矿产地质研究院有限公司、北矿检测技术有限公司、紫金铜业有限公司、大冶有色设计研究院有限公司、郴州市产商品质量监督检验所、铜陵有色金属集团控股有限公司、云南锡业矿冶检测中心有限公司、广东省韶关市质量计量监督检测所、黑龙江紫金铜业有限公司、安徽国家铜铅锌及制品质量监督检验中心 |

3、主要参加单位和工作成员及其所做的工作

3.1主要参加单位情况

国标（北京）检验认证有限公司是本标准的起草单位。在工作前期，对现阶段锡的检测需求、检测现状及国内外相关检测标准进行了充分的调研，并设计了采用电感耦合等离子体原子发射光谱法（ICP-AES）测定锡中铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴含量的实验方案。项目计划下达后，购买了6N超纯锡粒及锡成分分析用标准物质，并积极联系相关生产单位完成了锡公共样品的收集与筛选；完成ICP-AES测定锡中杂质元素的研究报告和《讨论稿》；发放样品并协调验证单位完成验证报告，并在综合各验证单位意见的基础上提出《征求意见稿》；负责汇总精密度数据，完成数理统计工作；负责意见征集与汇总；并负责在标准预审会、审定会上进行项目介绍与答辩，最终形成报批稿，协助标准化技术委员会秘书处完成标准的报批工作。

云南锡业股份有限公司锡业分公司、柳州华锡有色设计研究院有限责任公司、深圳市中金岭南有色金属股份有限公司、国合通用（青岛）测试评价有限公司、中国检验认证集团广西有限公司、昆明冶金研究院有限公司、阜阳市产品质量监督检验所等**7**家单位是方法的一验单位，负责逐条验证《研究报告》的内容，对方法的可行性进行论证并给出结论；负责提供本试验室公共样品的原始测定数据；协助起草单位完成标准报批稿的校核工作。云南锡业股份有限公司、广西华锡矿业有限公司、昆明冶金研究院有限公司同时作为样品的提供单位，协助起草单位筹集锡公共样品。

中国有色桂林矿产地质研究院有限公司、北矿检测技术有限公司、紫金铜业有限公司、大冶有色设计研究院有限公司、郴州市产商品质量监督检验所、铜陵有色金属集团控股有限公司、云南锡业矿冶检测中心有限公司、广东省韶关市质量计量监督检测所、黑龙江紫金铜业有限公司、安徽国家铜铅锌及制品质量监督检验中心等10家单位是方法的二验单位，主要按照《研究报告》中的试验步骤完成公共样品的测定并提供原始测定数据，对于试验中发现的问题及时反馈给起草单位。

3.2主要工作成员所负责的工作情况

本标准主要起草人及工作职责见表2。

表2 主要起草人及工作职责

|  |  |
| --- | --- |
| 起草人 | 工作职责 |
| 墨淑敏、张鑫 | 负责方法的起草，各阶段标准文本、编制说明的编写，参加标准工作会议等。 |
| 李爱嫦、郑佳乐 | 数据统计、协助完成ICP-AES的相关试验。 |
| 陈雄飞 | 协助联络单位购置标样等。 |
| 谭凤、杨敏、陈思、梁闪坐、甘雄胜、蒙雪忍、袁丽丽、胡胭脂、王兴君、刘含笑、张璐、吴雪英、刘英波、王劲榕、施昱、邢化冰、鲁仕梅 | 负责方法一验工作，对条件实验进行了验证，并完成精密度原始数据。提供公共样品，负责公共样品的制备等工作。 |
| 古行乾、苏春风、甘聪、胡梅花、陈兰、潘晓玲、谢磊、杨华东、王洋、李长春、柴徐彬、胡红丹、袁齐、陈宇、沈显丽、臧真娟、孙国娟、顾菲菲 | 负责二验，提供了精密度原始数据。 |

4、主要工作过程

4.1 起草阶段

（1）任务落实

2021年8月，国家标准化管理委员会正式批复本项目，项目计划编号为20213147-T-610。2021年10月全国有色金属标准化技术委员会在常州召开工作会议，对本项目进行任务落实。会议明确了项目的时间进度安排，并确定国标（北京）检验认证有限公司为负责起草单位，云南锡业股份有限公司锡业分公司、柳州华锡有色设计研究院有限责任公司、深圳市中金岭南有色金属股份有限公司、国合通用（青岛）测试评价有限公司、中国检验认证集团广西有限公司、昆明冶金研究院有限公司、阜阳市产品质量监督检验所等共17家单位参与本方法的一验和二验。

（2）样品收集

2021年11月，起草单位成立GB/T3260.12《锡化学分析方法 第 12 部分：铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴含量的测定 电感耦合等离子体原子发射光谱法》研发组。经调研，目前市场上存在商业化的《锡铸态光谱单点标准样品》包括GSB 04-3610-2019 Sn99.90%AA锡标样和GSB 04-3610-2019 Sn99.90%A锡标样。为保证方法的准确性，起草单位购买上述2个锡标准物质作为公共样品。同时购买峨半高纯材料有限公司6N高纯锡进行条件实验，并通过加标成出杂质含量在测定范围下限的公共样品2个。

样品提供单位积极协助筹集样品，对锡生产线产品进行监测。云南锡业股份有限公司提供6个锡产品、柳州华锡有色设计研究院有限责任公司提供5个锡产品，昆明冶金研究院提供2个锡锭产品。2022年1月，起草单位收到样品后对样品进行均检、初筛，选定其中8个样品作为公共样品。

综上，至2022年1月，编制组共确定12个锡公共样品，详见表3-1。

表3-1 公共样品初筛情况

| 来源 | 购自峨眉半导体 | | 锡标准物质（购买） | | 昆明冶金院提供 | | 云锡提供 | | | 华锡提供 | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 编号 | 1#  6N合成 | 2#  6N合成 | 3#标样  99.90%AA | 4#标样  99.90%A  +50ug/g  除Pb | 5#  21-0023 | 6#  21-0029 | 7#  981580 | 8#  190030C | 9#  1355-1 | 10#  2021.10-46 | 11#  2021.10-39 | 12#  21-333 |
| Bi | 0.002 | 0.005 | 0.0144 | 0.0243 | — | 0.048 | 0.006 | (( 0.23 )) | (( 0.28 )) | (( 0.16 )) | (( 0.18 )) | 0.007 |
| Pb | 0.002 | 0.005 | 0.0087 | 0.0293 | — | — | 0.04 | (( 3.3 )) | (( 4.2 )) | (( 4.7 )) | (( 5.2 )) | 0.004 |
| Sb | 0.002 | 0.005 | 0.0172 | 0.0239 | — | 0.051 | 0.01 | 0.005 | (( 0.6 )) | (( 2.3 )) | (( 2.3 )) | — |
| As | 0.002 | — | 0.0050 | 0.0109 | 0.02 | 0.045 | — | — | — | (( 0.4 )) | (( 0.5 )) | — |
| Cu | 0.0003 | 0.001 | 0.0075 | 0.0137 | — | 0.045 | 0.006 | 0.018 | 0.033 | (( 0.26 )) | (( 0.5 )) | — |
| Fe | 0.0003 | 0.001 | 0.0036 | 0.0089 | 0.02 | 0.045 | 0.002 | 0.001 | — | — | — | 0.002 |
| Al | 0.0003 | 0.001 | 0.00024 | 0.0053 | 0.02 | 0.045 | — | — | — | — | — | — |
| Zn | 0.0003 | 0.001 | 0.00014 | 0.0050 | 0.02 | 0.045 | — | — | — | — | — | — |
| Cd | 0.0003 | 0.001 | 0.00056 | 0.0061 | 0.02 | 0.045 | — | — | — | — | — | — |
| Ag | 0.0003 | 0.001 | 0.0048 | 0.0107 | 0.02 | 0.045 | — | 0.004 | 0.005 | 0.013 | 0.011 | — |
| Ni | 0.0003 | 0.001 | 0.0022 | 0.0077 | — | — | — | 0.004 | 0.018 | 0.02 | 0.04 | — |
| Co | 0.0003 | 0.001 | 0.0021 | 0.0075 | 0.02 | 0.045 | — | 0.0008 | — | — | — | — |

（3）试验研究

2022年1月~4月，起草单位通过一系列条件实验对锡样品的溶解方法、谱线的选择、酸度的影响、方法检出限和测定下限等关键实验要素进行了确定。按照确定的实验方法，对12个公共样品进行精密度测试，并对数据的平均值和相对标准偏差进行整理汇总。

2022年4月初，起草单位撰写完成本项目的 《研究报告》，并按照GB/T 1.1-2020的规定撰写了GB/T 3260.12《锡化学分析方法 第 12 部分：铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴含量的测定 电感耦合等离子体原子发射光谱法》（讨论稿）。

（4）验证单位验证情况

2022年4月，起草单位将样品和方法研究报告邮寄给各验证单位进行数据的验证工作。至2022年7月底，各验证单位陆续完成验证工作并返回验证报告。验证单位反馈的主要意见包括以下内容：a）部分单位无耐氢氟酸进样系统，无法采用硝酸氢氟酸溶样；b）多元素混合标准溶液配制过程中有沉淀生成。

为了便于方法的推广应用，经多次条件实验后，本方法提供硝酸+氢氟酸和盐酸+硝酸两种样品分解方法。多元素混合标准溶液将银分开单独配制。

起草单位综合各验证单位反馈意见对《讨论稿》进行修改完善，形成GB/T 3260.12《锡化学分析方法 第 12 部分：铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴含量的测定 电感耦合等离子体原子发射光谱法》（征求意见稿）。

4.2 征求意见阶段

2022年8月24日~26日有色标委会在湖北宜昌召开预审会。来自有株洲冶炼集团股份有限公司、酒泉钢铁集团有限责任公司、云南铜业股份有限公司等单位的40多位专家对《锡化学分析方法 第 12 部分：铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴含量的测定 电感耦合等离子体原子发射光谱法》《征求意见稿》进行了讨论，并提出了宝贵意见。

2022年 9月2日至 2022年 11月3日，全国有色金属标准化技术委员会将征求意见资料在国家标准化管理委员会的“公共信息服务平台”上挂网，向社会公开征求意见。同时，全国有色金属标准化技术委员会通过工作群、邮件向委员单位征求意见，并将征求意见资料在 www.cnsmq.com 网站上挂网。征求意见的单位包括主要生产、经销、使用、科研、检验等单位及大专院校，征求意见单位广泛且具有代表性，征求意见时间大于 2 个月。

整个征求意见过程中，标准编制组发送“征求意见稿”的单位数有29个，收到“征求意见稿”后，回函并有建议或意见的单位数有7个，没有未回函的单位。截至2022 年11月底，编制组共收到7条意见，对收集到的意见进行整理，形成了意见汇总处理表。

根据相关意见，编制组对征求意见稿进行修改，2022年12月初，完成了《锡化学分析方法 第 12 部分：铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴含量的测定 电感耦合等离子体原子发射光谱法》（送审稿）。

4.3 审定阶段

4.4 报批阶段

二、标准编制原则

本标准起草过程中遵循以下原则：

（一）规范性原则：本标准是根据GB/T 1.1-2020《标准化工作导则 第1部分:标准化文件的结构和起草规则》和GB/T 20001.4-2015《标准编写规则 第4部分：试验方法标准》的要求进行编写的；并按照GB/T 6379.2-2004《测量方法与结果的准确度（正确度与精密度）第2部分：确定标准测量方法重复性与再现性的基本方法》进行数理统计分析。

（二）先进性：本次制定的电感耦合等离子体原子发射光谱法测定锡中铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴含量的方法标准，能够准确的对锡中杂质元素进行定量分析，且产品标准中规定的12种金属元素同时测定，流程短、步骤简便、易于推广。本标准在国内外均为首次制定，具有前瞻性和引领性。

（三）适用性：本标准以满足我国锡产品实际检测需求为原则，宜于应用，能够满足企业需求。在标准的制定中既有云南锡业股份有限公司锡业分公司、柳州华锡有色设计研究院有限责任公司等国内最大的锡生产企业的参与也有锡产品的使用单位及各检测机构的广泛参与。本分析方法标准适用于锡产品标准化学成分的检测。标准的技术内容符合我国当前的检测实际，对生产企业的技术进步产生积极的促进作用。

（四）合规性：充分考虑国家法律、安全、卫生、环保法规的要求。

三、标准主要内容的确定依据

本标准为首次制定标准。因此在标准的制定过程中主要对元素的种类和测定范围、样品溶解方法、谱线、基体效应、酸度、方法检出限和测定下限以及重复性限和再现性限等几个方面进行了确认：

1. 元素种类及测定范围

本方法涉及锡中铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴等12种杂质元素的测定，铋、铅、锑、砷的测定范围为0.002%～0.050%，铜、铁、铝、锌、镉、银、镍、钴的测定范围为0.0003%～0.050%。元素种类及测定范围确定的主要依据是GB/T 728-2020《锡锭》、GB/T 26304-2010《锡粉》等锡的产品标准。根据上述产品标准，Sn99.90A、Sn99.90AA、Sn99.95A、Sn99.95AA等牌号的锡产品需要测定铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴、硫共13种元素，并通过差减得到锡的纯度。本方法可同时测定除硫外的所有杂质元素。

1. 样品溶解方法

GB/T 3260《锡化学分析方法》第1-10部分，多采用盐酸+硝酸、盐酸+过氧化氢、盐酸+硝酸+硫酸等混酸溶样。本方法包含12种杂质元素，基于元素共存、溶液稳定性等考虑起草单位经试验研究推荐采用硝酸+氢氟酸的溶样方式。具体为：称取0.50 g试料置于100 mL聚四氟乙烯烧杯中，加入5 mL水润湿。然后加入1.5 mL氢氟酸并缓慢滴加2.5 mL硝酸。该溶样方法使用的化学试剂少，样品溶解速度快，无需加热即可溶液至澄清，且放置一周均可稳定存在。

《讨论稿》发送给验证单位后，部分验证单位表示设备未配置耐氢氟酸装置。为了便于方法的推广应用，起草单位对盐酸溶样方法进行了研究。对比了盐酸+过氧化氢和盐酸+硝酸的溶样方法，再与各单位充分讨论后推荐盐酸+硝酸作为第2种溶样方法。具体为：称取0.50 g试料置于100 mL聚四氟乙烯烧杯中，加入5 mL水润湿。依次加入7.5 mL盐酸和2.5 mL硝酸，盖上杯盖，低温加热至溶解完全，冷却至室温。

试验采用三种方法分别对GSB 04-3610-2019《锡铸态光谱单点标准样品》锡（99.90A）标样以及7、8、9、10、11公共样品进行了对比测定，结果见表4和表5。结果表明，采用三种溶样方法结果无显著差异，标样测定结果与标准值基本吻合。

表4 不同溶样方法测定GSB 04-3610-2019 锡（99.90A）标样结果对比

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 元素 | 氢氟酸+硝酸  结果/% | 盐酸+过氧化氢  结果/% | 盐酸+硝酸  结果/% | 标准值/% | 不确定度/% |
| Cu | 0.00913 | 0.00905 | 0.00898 | 0.0087 | 0.0008 |
| Fe | 0.00375 | 0.00355 | 0.00378 | 0.0039 | 0.0007 |
| Bi | 0.0199 | 0.0198 | 0.0199 | 0.0193 | 0.0006 |
| Pb | 0.0292 | 0.0291 | 0.0298 | 0.0293 | 0.0008 |
| Sb | 0.0196 | 0.0198 | 0.0198 | 0.0189 | 0.0004 |
| As | 0.00634 | 0.00628 | 0.00648 | 0.0059 | 0.0009 |
| Al | <0.0003 | <0.0003 | <0.0003 | 0.00029 | 0.0009 |
| Zn | <0.0003 | <0.0003 | <0.0003 | 0.00017 | 0.00004 |
| Cd | 0.00116 | 0.00114 | 0.00112 | 0.0011 | 0.0002 |
| Ag | 0.00581 | 0.00576 | 0.00570 | 0.0057 | 0.0003 |
| Ni | 0.00283 | 0.00284 | 0.00281 | 0.0027 | 0.0002 |
| Co | 0.00274 | 0.00268 | 0.00269 | 0.0025 | 0.0003 |

表5 不同溶样方法测定锡样品结果对比

| 样品编号 | 元素 | 氢氟酸+硝酸  结果/% | 盐酸+过氧化氢  结果/% | 盐酸+硝酸  结果/% |
| --- | --- | --- | --- | --- |
| 7#  （981580） | Cu | 0.00637 | 0.00645 | 0.00613 |
| Fe | 0.00279 | 0.00261 | 0.00269 |
| Bi | 0.00667 | 0.00685 | 0.00675 |
| Pb | 0.0450 | 0.0432 | 0.0444 |
| Sb | 0.0120 | 0.0125 | 0.0124 |
| 8#  （190030C） | Cu | 0.0185 | 0.0181 | 0.0181 |
| Fe | 0.00113 | 0.00100 | 0.00101 |
| Sb | 0.00561 | 0.00582 | 0.00596 |
| Ag | 0.00396 | 0.00386 | 0.00388 |
| Ni | 0.00447 | 0.00443 | 0.00440 |
| Co | 0.00089 | 0.00086 | 0.00083 |
| 9#  （1355-1） | Cu | 0.0326 | 0.0330 | 0.0332 |
| Ag | 0.00483 | 0.00486 | 0.00496 |
| Ni | 0.0176 | 0.0174 | 0.0178 |
| Co | 0.00090 | 0.00087 | 0.00088 |
| 10#  （2021.10-46） | Ag | 0.0133 | 0.0139 | 0.0140 |
| Ni | 0.0206 | 0.0209 | 0.0207 |
| 11#  （2021.10-39） | Ag | 0.0112 | 0.0119 | 0.0116 |
| Ni | 0.0420 | 0.0431 | 0.0429 |

综合反应速度、操作的方便程度，本标准推荐两种样品溶解方法处理锡试料，分别采用氢氟酸+硝酸和盐酸+硝酸混酸溶样。经标准样品验证上述方法能够准确测定锡中杂质元素。

3、谱线的选择

本方法对元素检出限有较高要求，因此优先选择干扰小，且灵敏度高的分析线进行测定，结果见表6。

表6 各元素的推荐谱线

| 元素 | 波长λ/nm | 元素 | 波长λ/nm |
| --- | --- | --- | --- |
| Cu | 324.75 | Al | 396.15 |
| Fe | 238.20 | Zn | 213.85 |
| Bi | 223.06 | Cd | 226.50 |
| Pb | 220.35 | Ag | 328.06 |
| Sb | 217.58 | Ni | 230.29 |
| As | 188.98 / 193.69 | Co | 237.86 |

4、基体浓度的影响

分别称取0、0.10 g、0.20 g、0.50 g、1.00g高纯锡，加入5 mL硝酸，3 mL氢氟酸，低温加热至完全溶解，冷却后移入100 mL塑料容量瓶中。依次加入2 mL质量浓度为50 μg/mL的混合标准溶液，稀释至刻度。此时基体浓度分别为0 mg/mL、1mg/mL、2mg/mL、5mg/mL、10mg/mL，各元素浓度均为1 μg/mL。在推荐波长处测定各待测元素的发射强度，不同基体浓度下结果见表7。

表7 基体浓度的影响

| 元素及谱线 | 基体浓度 | | | | |
| --- | --- | --- | --- | --- | --- |
| 0 mg/mL | 1mg/mL | 2mg/mL | 5mg/mL | 10mg/mL |
| Cu 324.75 | 6711.9 | 6701.1 | 6655.8 | 6579.2 | 6339.6 |
| Fe 238.20 | 3724.8 | 3663.6 | 3634.2 | 3599.9 | 3477.7 |
| Bi 223.06 | 380.6 | 377.6 | 372.8 | 367.9 | 350.4 |
| Pb 220.35 | 283.5 | 284.7 | 282.7 | 281.1 | 270.5 |
| Sb 217.58 | 136.4 | 134.9 | 136.2 | 136.2 | 131.9 |
| As 188.98 | 409.2 | 401.4 | 398.5 | 390.5 | 369.9 |
| Al 396.15 | 4420.6 | 4436.9 | 4436.3 | 4374.9 | 4224.5 |
| Zn 213.85 | 6602.7 | 6560.1 | 6532.2 | 6432.3 | 6184.9 |
| Cd 226.50 | 6929.6 | 6926.6 | 6886.0 | 6796.1 | 6559.6 |
| Ag 328.06 | 6653.4 | 6646.7 | 6607.7 | 6507.7 | 6261.4 |
| Ni 230.29 | 1575.4 | 1554.5 | 1553.1 | 1526.6 | 1475.7 |
| Co 237.86 | 2109.1 | 2081.8 | 2065.4 | 2001.5 | 1900.0 |

由表7数据可知：随着基体浓度的增加，各元素发射强度降低，灵敏度下降，基体对信号具有抑制作用。当基体浓度为10 mg/mL时各元素灵敏度下降5%～10%。为了提高测试结果的准确度，采用电感耦合等离子体发射光谱测定铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴含量时，标准溶液需要采用99.999%的高纯锡进行基体匹配。

5、酸度对测定的影响

向一组50mL容量瓶中加入氢氟酸均1.5mL，分别加入0.5mL、1.5mL、2.5mL、3.5mL和5mL硝酸。在不同酸度下测定质量浓度为1.00 µg/mL的各杂质元素的发射强度，结果见表8-1。

向一组50mL容量瓶中分别加入2.5mL、5.0mL、7.0mL、8.0mL、9.0mL、10.0mL王水。在不同酸度下测定质量浓度为1.00 µg/mL的各杂质元素的发射强度，结果见表8-2。

表8-1 硝酸体积分数对测定的影响(氢氟酸+硝酸溶样)

| 元素及谱线 | 硝酸体积分数 | | | | |
| --- | --- | --- | --- | --- | --- |
| 1% | 3% | 5% | 7% | 10% |
| Cu 324.75 | 24119 | 23466 | 23038 | 23031 | 22450 |
| Fe 238.20 | 9150 | 8768 | 8552 | 8465 | 8161 |
| Bi 223.06 | 1124 | 1083 | 1046 | 1027 | 991 |
| Pb 220.35 | 608 | 595 | 571 | 566 | 546 |
| Sb 217.58 | 352 | 344 | 325 | 328 | 312 |
| As 188.98 | 511 | 488 | 467 | 468 | 441 |
| As 193.69 | 527 | 500 | 479 | 471 | 449 |
| Al 396.15 | 19282 | 18508 | 17954 | 17761 | 17155 |
| Zn 213.85 | 14191 | 13547 | 13094 | 12949 | 12408 |
| Cd 226.50 | 16897 | 16146 | 15652 | 15422 | 14826 |
| Ag 328.06 | 22869 | 21990 | 21441 | 21247 | 20496 |
| Ni 230.29 | 3199 | 3080 | 2993 | 2962 | 2823 |
| Co 237.86 | 4329 | 4149 | 4054 | 4017 | 3863 |

表8-2王水体积分数对测定的影响（2022年9月补充试验）

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 元素及谱线 | 王水体积分数 | | | | | |
| 5% | 10% | 14% | 16% | 18% | 20% |
| Cu 324.75 | 47811 | 47749 | 47913 | 47710 | 47466 | 47478 |
| Fe 238.20 | 17934 | 17667 | 17569 | 17352 | 17304 | 17243 |
| Bi 223.06 | 3931 | 3794 | 3765 | 3731 | 3692 | 3678 |
| Pb 220.35 | 1511 | 1492 | 1482 | 1486 | 1481 | 1499 |
| Sb 217.58 | 1093 | 1107 | 1085 | 1071 | 1092 | 1074 |
| As 188.98 | 860 | 841 | 844 | 836 | 831 | 821 |
| As 193.69 | 732 | 713 | 713 | 707 | 697 | 706 |
| Al 396.15 | 36605 | 36115 | 36110 | 35922 | 35586 | 35601 |
| Zn 213.85 | 24534 | 23091 | 23151 | 22750 | 22839 | 22732 |
| Cd 226.50 | 27366 | 26861 | 26612 | 26285 | 26203 | 26122 |
| Ag 328.06 | 18478 | 18219 | 18129 | 17898 | 17898 | 17795 |
| Ni 230.29 | 4008 | 3954 | 3922 | 3881 | 3873 | 3846 |
| Ni 231.60 | 6388 | 6310 | 6247 | 6180 | 6156 | 6148 |
| Co 237.86 | 5948 | 5844 | 5830 | 5775 | 5729 | 5695 |
| Co 238.89 | 9457 | 9352 | 9265 | 9140 | 9130 | 9071 |

由表8-1和表8-2数据可知：随着酸度的增加，元素发射强度有不同程度的下降。为了提高测定结果的准确度，标准溶液与样品溶液酸度应保持一致。

本标准采用基体匹配法配制工作曲线，配制标准溶液的高纯锡与试料按照相同试验步骤处理。试验发现，采用氢氟酸+硝酸溶样时，样品溶解速度快，0.5g样品2~5min即可溶解完全，体积损失小于1mL；王水溶样时，样品溶解速度稍慢，5~10min也可溶解完全，即使200℃电热板加热25min，体积损失2mL左右。因此，标准溶液和样品溶液酸度基本一致，不再单独补酸。

6、方法检出限和测定下限

采用高纯锡，配制Sn质量浓度为10 mg/mL的空白溶液，独立测定11次。以3倍标准偏差计算检出限，以10倍标准偏差计算方法的测定下限。结果见表9-1和表9-2。

表9-1 方法检出限和测定下限（氢氟酸+硝酸溶样）

| 元素 | 空白平均值  （n=11） | 空白标准偏差  *S*B（n=11） | 标准平均值  （n=11） | 检出限  *ρ*L/(μg/mL) | 测定下限  （%） |
| --- | --- | --- | --- | --- | --- |
| Cu 324.75 | 35.6 | 7.8 | 8260 | 0.0028 | 0.00010 |
| Fe 238.20 | 53.2 | 2.7 | 4654 | 0.0018 | 0.00007 |
| Bi 223.06 | 10.3 | 3.5 | 443.3 | 0.024 | 0.00082 |
| Pb 220.35 | 16.5 | 2.6 | 349.7 | 0.023 | 0.00078 |
| Sb 217.58 | 8.3 | 1.9 | 173.2 | 0.034 | 0.0012 |
| As 188.98 | 11.2 | 3.3 | 471.2 | 0.022 | 0.00073 |
| Al 396.15 | 88.9 | 7.1 | 5415 | 0.0040 | 0.00013 |
| Zn 213.85 | 42.1 | 3.2 | 7613 | 0.0013 | 0.00005 |
| Cd 226.50 | 7.8 | 2.8 | 8769 | 0.0010 | 0.00004 |
| Ag 328.06 | 22.5 | 4.2 | 7999 | 0.0016 | 0.00005 |
| Ni 230.29 | 12.6 | 2.6 | 1944 | 0.0040 | 0.00013 |
| Co 237.86 | 5.2 | 2.0 | 2440 | 0.0024 | 0.00008 |

表9-2 方法检出限和测定下限（盐酸+硝酸溶样）

| 元素 | 空白平均值 | 空白标准偏差 | 标准平均值 | 检出限 | 测定下限 |
| --- | --- | --- | --- | --- | --- |
| （n=11） | *S*B（n=11） | （n=11） | *ρ*L/(μg/mL) | （%） |
| Cu 324.75 | 39.0 | 8.2 | 7358.0 | 0.0034 | 0.00012 |
| Fe 238.20 | 10.8 | 36.1 | 14194.0 | 0.0008 | 0.00003 |
| Bi 223.06 | 21.9 | 2.9 | 649.6 | 0.013 | 0.00045 |
| Pb 220.35 | 44.0 | 5.3 | 1114.8 | 0.014 | 0.00047 |
| Sb 217.58 | 15.2 | 3.4 | 853.5 | 0.012 | 0.00040 |
| As 188.98 | 11.9 | 3.4 | 592.5 | 0.017 | 0.00057 |
| Al 396.15 | 55.6 | 9.5 | 5355.1 | 0.005 | 0.00017 |
| Zn 213.85 | 31.8 | 4.8 | 17886.5 | 0.0008 | 0.00003 |
| Cd 226.50 | 9.2 | 3.3 | 19247.3 | 0.0005 | 0.00002 |
| Ag 328.06 | 43.2 | 8.9 | 14263.0 | 0.0019 | 0.00007 |
| Ni 230.29 | 184.3 | 5.9 | 5062.7 | 0.0035 | 0.00012 |
| Co 237.86 | 10.2 | 3.2 | 4522.8 | 0.0021 | 0.00007 |

本方法中铋、铅、锑、砷的测定范围下限为0.0020%及铜、铁、铝、锌、镉、银、镍、钴的测定范围下限为0.0003%。因此，两种溶样方法的测定下限都能够满足上述元素的要求。

6、精密度数据的确定

精密度数据是在2022年由18家试验室对5至6个不同水平样品进行共同试验确定的。每个实验室对每个水平的铜、铁、铋、铅、锑、砷、铝、锌、镉、银、镍、钴含量在重复性条件下独立测定7次。18家实验室代码见表10。各实验室原始数据见附录表A.1～A.12，其中以\*标记的实验室其数据为离群值。

表10 精密度数据提供实验室代码

| 代码 | 实验室名称 | 代码 | 实验室名称 | 代码 | 实验室名称 |
| --- | --- | --- | --- | --- | --- |
| 1 | 国标（北京）检验认证有限公司 | 7 | 安徽国家铜铅锌及制品质量监督检验中心 | 13 | 昆明冶金研究院有限公司 |
| 2 | 柳州华锡有色设计研究院有限责任公司 | 8 | 黑龙江紫金铜业有限公司 | 14 | 紫金铜业有限公司 |
| 3 | 阜阳市产品质量监督检验所 | 9 | 中国有色桂林矿产地质研究院有限公司 | 15 | 云南锡业股份有限公司锡业分公司 |
| 4 | 深圳市中金岭南有色金属股份有限公司 | 10 | 北矿检测技术有限公司 | 16 | 大冶有色设计研究院有限公司 |
| 5 | 郴州市产商品质量监督检验所 | 11 | 中国检验认证集团广西公司 | 17 | 广东省韶关市质量计量监督检测所 |
| 6 | 铜陵有色金属集团控股有限公司 | 12 | 国合通用（青岛）测试评价有限公司 | 18 | 云南锡业矿冶检测中心有限公司 |

在测定数据进行柯克伦检验及格拉布斯检验，剔除离群值后，进行精密度数据计算，从而确定重复性限和再现性限。各杂质元素统计分析后结果可接受的实验室个数、平均值及重复性标准差、再现性标准差、重复性限、再现性限见表11。从而确定方法的重复性限和再现性限，分别见表12、表13。

表11 实验室间数据统计结果

| 元素 | 水平 | 结果可接受的  实验室个数 | 平均值  /% | 重复性标准差  *Sr* | 再现性标准差  *SR* | 重复性限  *r*/% | 再现性限  *R*/% |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Cu | 1 | 18 | 0.00030 | 0.00002 | 0.00002 | 0.00005 | 0.00006 |
| 2 | 16 | 0.0010 | 0.00004 | 0.00004 | 0.00010 | 0.00011 |
| 3 | 16 | 0.0064 | 0.000110 | 0.00011 | 0.00030 | 0.00032 |
| 4 | 18 | 0.0200 | 0.000340 | 0.00054 | 0.0010 | 0.0015 |
| 5 | 17 | 0.0329 | 0.00044 | 0.00076 | 0.0012 | 0.0022 |
| 6 | 17 | 0.0452 | 0.00059 | 0.00070 | 0.0017 | 0.0020 |
| Fe | 1 | 17 | 0.00030 | 0.00002 | 0.00002 | 0.00005 | 0.00006 |
| 2 | 17 | 0.00101 | 0.000041 | 0.00005 | 0.0001 | 0.00014 |
| 3 | 17 | 0.00336 | 0.00009 | 0.00016 | 0.00024 | 0.00046 |
| 4 | 14 | 0.00881 | 0.00008 | 0.00015 | 0.00024 | 0.00041 |
| 5 | 17 | 0.0202 | 0.00049 | 0.00083 | 0.0014 | 0.0024 |
| 6 | 15 | 0.0451 | 0.00061 | 0.00069 | 0.0017 | 0.0020 |
| Bi | 1 | 16 | 0.00199 | 0.00004 | 0.00008 | 0.00013 | 0.00025 |
| 2 | 14 | 0.00664 | 0.00014 | 0.00021 | 0.00040 | 0.00059 |
| 3 | 17 | 0.0143 | 0.00029 | 0.00050 | 0.0008 | 0.0014 |
| 4 | 16 | 0.0244 | 0.00041 | 0.00093 | 0.0012 | 0.0026 |
| 5 | 13 | 0.0489 | 0.00053 | 0.00071 | 0.0015 | 0.0020 |
| Pb | 1 | 18 | 0.00201 | 0.00005 | 0.00007 | 0.00015 | 0.00022 |
| 2 | 17 | 0.00500 | 0.000071 | 0.00010 | 0.00021 | 0.00029 |
| 3 | 16 | 0.00857 | 0.00011 | 0.00012 | 0.00029 | 0.00033 |
| 4 | 16 | 0.0293 | 0.00046 | 0.00104 | 0.0013 | 0.0029 |
| 5 | 16 | 0.0441 | 0.00084 | 0.00195 | 0.0024 | 0.0055 |
| Sb | 1 | 17 | 0.00201 | 0.00007 | 0.00011 | 0.00018 | 0.00031 |
| 2 | 16 | 0.00550 | 0.00010 | 0.00028 | 0.00029 | 0.00079 |
| 3 | 17 | 0.0120 | 0.00040 | 0.00073 | 0.0011 | 0.0021 |
| 4 | 15 | 0.0241 | 0.00048 | 0.00061 | 0.0014 | 0.0017 |
| 5 | 14 | 0.0510 | 0.00051 | 0.00082 | 0.0015 | 0.0023 |
| As | 1 | 17 | 0.00200 | 0.00007 | 0.00010 | 0.00019 | 0.00029 |
| 2 | 16 | 0.00502 | 0.00011 | 0.00024 | 0.00032 | 0.00069 |
| 3 | 18 | 0.0109 | 0.00035 | 0.00060 | 0.0010 | 0.0017 |
| 4 | 17 | 0.0201 | 0.00055 | 0.00081 | 0.0016 | 0.0023 |
| 5 | 16 | 0.0453 | 0.00067 | 0.00096 | 0.0019 | 0.0027 |
| Al | 1 | 17 | 0.00031 | 0.00002 | 0.00003 | 0.00005 | 0.00009 |
| 2 | 16 | 0.00101 | 0.00005 | 0.00005 | 0.00013 | 0.00015 |
| 3 | 15 | 0.00506 | 0.00009 | 0.00012 | 0.00027 | 0.00034 |
| 4 | 17 | 0.0199 | 0.00035 | 0.00084 | 0.0010 | 0.0024 |
| 5 | 15 | 0.0450 | 0.00063 | 0.00070 | 0.0018 | 0.0020 |
| Zn | 1 | 17 | 0.00031 | 0.00002 | 0.00002 | 0.00004 | 0.00005 |
| 2 | 17 | 0.00100 | 0.00004 | 0.00007 | 0.00010 | 0.00019 |
| 3 | 16 | 0.00501 | 0.00008 | 0.00096 | 0.00022 | 0.00027 |
| 4 | 17 | 0.0202 | 0.00044 | 0.00072 | 0.0013 | 0.0020 |
| 5 | 16 | 0.0448 | 0.00047 | 0.00079 | 0.0013 | 0.0023 |
| Cd | 1 | 18 | 0.00031 | 0.00002 | 0.00002 | 0.00005 | 0.00006 |
| 2 | 18 | 0.00100 | 0.00003 | 0.00005 | 0.00009 | 0.00013 |
| 3 | 18 | 0.00605 | 0.00009 | 0.00017 | 0.00025 | 0.00048 |
| 4 | 17 | 0.0200 | 0.00037 | 0.00065 | 0.0011 | 0.0018 |
| 5 | 17 | 0.0450 | 0.00048 | 0.00095 | 0.0013 | 0.0027 |
| Ag | 1 | 16 | 0.00030 | 0.00002 | 0.00002 | 0.00004 | 0.00005 |
| 2 | 16 | 0.00102 | 0.00004 | 0.00004 | 0.00010 | 0.00012 |
| 3 | 17 | 0.00484 | 0.000080 | 0.00015 | 0.00022 | 0.00044 |
| 4 | 13 | 0.0107 | 0.000170 | 0.00052 | 0.00048 | 0.0015 |
| 5 | 16 | 0.0204 | 0.00038 | 0.00104 | 0.0011 | 0.0030 |
| 6 | 16 | 0.0455 | 0.00067 | 0.00086 | 0.0019 | 0.0024 |
| Ni | 1 | 16 | 0.00030 | 0.00002 | 0.00002 | 0.00005 | 0.00006 |
| 2 | 18 | 0.00099 | 0.00004 | 0.00006 | 0.00010 | 0.00016 |
| 3 | 15 | 0.00233 | 0.00007 | 0.00008 | 0.00019 | 0.00024 |
| 4 | 18 | 0.00768 | 0.00010 | 0.00027 | 0.00028 | 0.00076 |
| 5 | 13 | 0.0207 | 0.00028 | 0.00063 | 0.0008 | 0.0018 |
| 6 | 16 | 0.0415 | 0.00049 | 0.00173 | 0.0014 | 0.0049 |
| Co | 1 | 16 | 0.00031 | 0.00002 | 0.00002 | 0.00004 | 0.00004 |
| 2 | 18 | 0.00101 | 0.00003 | 0.00006 | 0.00008 | 0.00018 |
| 3 | 18 | 0.00211 | 0.00005 | 0.00008 | 0.00015 | 0.00021 |
| 4 | 18 | 0.00756 | 0.00009 | 0.00020 | 0.00025 | 0.00056 |
| 5 | 18 | 0.0202 | 0.00056 | 0.00090 | 0.0016 | 0.0025 |
| 6 | 16 | 0.0448 | 0.00051 | 0.00109 | 0.0015 | 0.0031 |

表12 重复性限

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *w*Cu /% | 0.00030 | 0.0010 | 0.0064 | 0.020 | 0.033 | 0.045 |
| *r*/% | 0.00004 | 0.0001 | 0.0003 | 0.001 | 0.002 | 0.004 |
| *w*Fe /% | 0.00030 | 0.0010 | 0.0034 | 0.0088 | 0.020 | 0.045 |
| *r*/% | 0.00005 | 0.0001 | 0.0003 | 0.0007 | 0.002 | 0.003 |
| *w*Bi /% | — | 0.0020 | 0.0066 | 0.014 | 0.024 | 0.049 |
| *r*/% | — | 0.0002 | 0.0004 | 0.001 | 0.002 | 0.003 |
| *w*Pb /% | — | 0.0020 | 0.0050 | 0.0086 | 0.029 | 0.044 |
| *r*/% | — | 0.0002 | 0.0004 | 0.0007 | 0.002 | 0.003 |
| *w*Sb /% | — | 0.0020 | 0.0055 | 0.017 | 0.027 | 0.051 |
| *r*/% | — | 0.0002 | 0.0003 | 0.001 | 0.002 | 0.002 |
| *w*As /% | — | 0.0020 | 0.0050 | 0.011 | 0.020 | 0.045 |
| *r*/% | — | 0.0002 | 0.0003 | 0.001 | 0.002 | 0.003 |
| *w*Al /% | 0.00031 | 0.0010 | 0.00506 | 0.020 | 0.045 | — |
| *r*/% | 0.00005 | 0.0001 | 0.00027 | 0.001 | 0.003 | — |
| *w*Zn /% | 0.00031 | 0.0010 | 0.0050 | 0.020 | 0.045 | — |
| *r*/% | 0.00004 | 0.0001 | 0.0002 | 0.001 | 0.002 | — |
| *w*Cd /% | 0.00031 | 0.0010 | 0.0061 | 0.020 | 0.045 | — |
| *r*/% | 0.00005 | 0.0001 | 0.0002 | 0.001 | 0.002 | — |
| *w*Ag /% | 0.00030 | 0.0010 | 0.0048 | 0.011 | 0.020 | 0.045 |
| *r*/% | 0.00004 | 0.0001 | 0.0003 | 0.001 | 0.002 | 0.003 |
| *w*Ni /% | 0.00030 | 0.0010 | 0.0023 | 0.0077 | 0.021 | 0.042 |
| *r*/% | 0.00005 | 0.0001 | 0.0002 | 0.0003 | 0.001 | 0.002 |
| *w*Co /% | 0.00031 | 0.0010 | 0.0021 | 0.0076 | 0.020 | 0.045 |
| *r*/% | 0.00004 | 0.0001 | 0.0002 | 0.0003 | 0.002 | 0.003 |

表13 再现性限

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *w*Cu /% | 0.00030 | 0.0010 | 0.0064 | 0.020 | 0.033 | 0.045 |
| *R*/% | 0.00005 | 0.0002 | 0.0004 | 0.002 | 0.003 | 0.005 |
| *w*Fe /% | 0.00030 | 0.0010 | 0.0034 | 0.0088 | 0.020 | 0.045 |
| *R*/% | 0.00006 | 0.0002 | 0.0005 | 0.0009 | 0.003 | 0.005 |
| *w*Bi /% | — | 0.0020 | 0.0066 | 0.014 | 0.024 | 0.049 |
| *R*/% | — | 0.0003 | 0.0006 | 0.002 | 0.003 | 0.005 |
| *w*Pb /% | — | 0.0020 | 0.0050 | 0.0086 | 0.029 | 0.044 |
| *R*/% | — | 0.0003 | 0.0006 | 0.0009 | 0.003 | 0.006 |
| *w*Sb /% | — | 0.0020 | 0.0055 | 0.017 | 0.027 | 0.051 |
| *R*/% | — | 0.0003 | 0.0008 | 0.002 | 0.003 | 0.003 |
| *w*As /% | — | 0.0020 | 0.0050 | 0.011 | 0.020 | 0.045 |
| *R*/% | — | 0.0003 | 0.0007 | 0.002 | 0.003 | 0.005 |
| *w*Al /% | 0.00031 | 0.0010 | 0.00506 | 0.020 | 0.045 | — |
| *R*/% | 0.00009 | 0.0002 | 0.00034 | 0.003 | 0.005 | — |
| *w*Zn /% | 0.00031 | 0.0010 | 0.0050 | 0.020 | 0.045 | — |
| *R*/% | 0.00005 | 0.0002 | 0.0003 | 0.002 | 0.003 | — |
| *w*Cd /% | 0.00031 | 0.0010 | 0.0061 | 0.020 | 0.045 | — |
| *R*/% | 0.00006 | 0.0002 | 0.0005 | 0.002 | 0.003 | — |
| *w*Ag /% | 0.00030 | 0.0010 | 0.0048 | 0.011 | 0.020 | 0.045 |
| *R*/% | 0.00005 | 0.0002 | 0.0005 | 0.002 | 0.003 | 0.005 |
| *w*Ni /% | 0.00030 | 0.0010 | 0.0023 | 0.0077 | 0.021 | 0.042 |
| *R*/% | 0.00006 | 0.0002 | 0.0003 | 0.0008 | 0.002 | 0.005 |
| *w*Co /% | 0.00031 | 0.0010 | 0.0021 | 0.0076 | 0.020 | 0.045 |
| *R*/% | 0.00005 | 0.0002 | 0.0003 | 0.0006 | 0.003 | 0.005 |

四、标准中涉及专利的情况

本标准不涉及专利和知识产权问题。

五、预期达到的社会效益

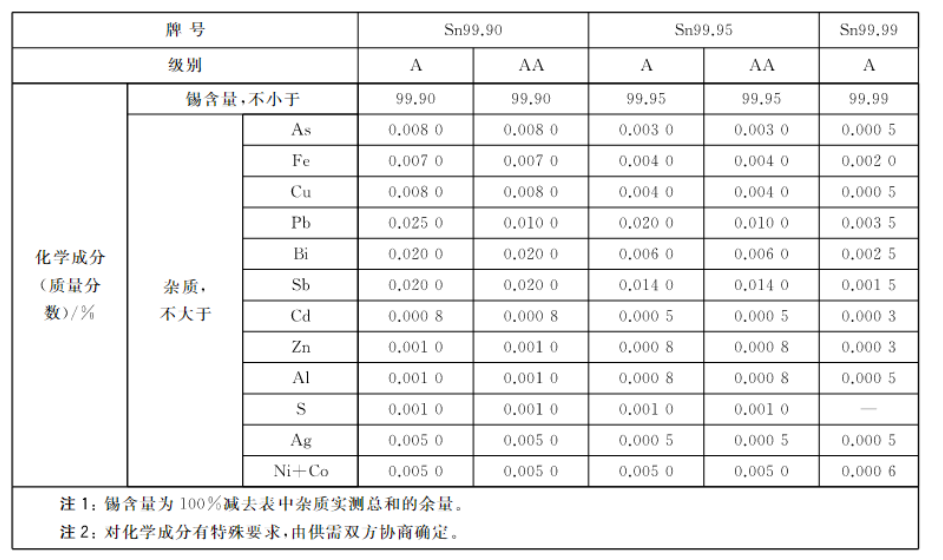
（一）项目的必要性

锡是人类最早使用的金属之一，也是最具广泛工业用途的金属之一，具有质地柔软，熔点低，展性强，塑性强和无毒等优良特性，主要用于制造焊锡、镀锡板、合金、化工制品等，被广泛应用于电子、信息、电器、化工、冶金、建材、机械、食品包装、原子能及航天工业等领域。随着经济的发展，其应用领域将不断扩大。

《战略新兴产业分类（2018）》中指出：锡冶炼（代码3.2.9.1）以及锡材料制造（代码3.2.9.6）属于战略性新兴产业，重点产品包括锡球、无铅焊锡粉等。锡中的杂质含量不仅影响产品的质量与性能，同时也是判定产品牌号的重要依据。产品标准GB/T 728-2020 《锡锭》中规定锡锭共分3个牌号5个级别，纯度由100%减去铜、铁、铋、铅、锑、砷、铝、锌、硫、镉、银、镍、钴等13种杂质总和计算得到，详见表14。

产品质量的提升离不开检测手段的大力支持，因此有必要建立健全锡化学分析方法。目前，纯锡相关检测方法有行业标准YS/T 36 《高纯锡化学分析方法》及国标GB/T 3260《锡化学分析方法》。其中，YS/T 36《高纯锡化学分析方法》主要采用电感耦合等离子体质谱法，其测定范围多为0.0000001%~0.0001%，不适用于锡锭等产品。GB/T 3260-2013《锡化学分析方法》共10个部分，分别为铜、铁、铋、铅、锑、砷、铝、锌、硫、镉杂质含量的测定。一方面，该系列标准尚未涉及银、镍、钴3种杂质元素测定方法的标准化；另一方面，该系列标准采用的方法均为经典的分光光度法和原子吸收光谱法，实验较为耗时耗力，无法满足客户快速检测的需求。

表14 锡锭化学成分（GB/T 728-2020）



总之，建立GB/T 3260.12《锡化学分析方法 第12部分：铜、铁、铋、铅、锑、砷、铝、锌、镉、镍、钴量的测定 电感耦合等离子体原子发射光谱法》对于确定产品级别有重要意义。该方法同时测定锡锭中12种金属元素，完善GB/T 3260《锡化学分析方法》标准体系的同时，有助于锡产品质量的提升，对促进锡产品的生产与贸易具有重要意义。

（二）项目的可行性

电感耦合等离子体发射光谱（ICP-AES）由于具备多元素同时检测、检出限低等优点，能够大大缩短检测时间，节省人力、物力。近些年ICP-AES异军突起，采用ICP-AES测定有色金属中杂质元素含量在相关的国家标准及行业标准均有颁布实施。例如GB/T 5121.27-2008《铜及铜合金化学分析方法 27部分:电感耦合等离子体原子发射光谱法》、YS/T 1164-2016《硅材料用高纯石英制品中杂质含量的测定 电感耦合等离子体发射光谱法》、GB/T 37248-2018《高纯氧化铝 痕量金属元素的测定 电感耦合等离子体发射光谱法》等。目前ICP-AES设备市场占有率高，方法标准化后能够大力推广应用。

起草单位国标（北京）检验认证公司具有丰富的测定锡产品中杂质元素含量的经验。项目前期调研过程中发现，云南锡业股份有限公司、柳州华锡有色设计研究院等国内重要的锡生产厂家以及深圳市中金岭南有色金属股份有限公司、昆明冶金研究院有限公司、北矿检测技术有限公司、紫金铜业有限公司等第三方检测机构及锡产品的使用单位均有采用ICP-AES技术对锡中杂质元素进行测定。美国ASTM F3139-2015《采用感应耦合等离子体发射光谱法分析次要和微量元素锡基焊料合金的标准试验方法》也采用ICP-AES对锡基合金中微量元素进行测定。因此，建立ICP-AES测定锡中杂质元素的方法在技术上是可行的，方法的标准化具有较好的社会基础。

此外，目前市场上已具有锡标准样品GSB 04-3610-2019《锡铸态光谱单点标准样品》，包括Sn99.90%A和Sn99.90%AA标准物质，其中铜、铁、铋、铅、锑、砷、铝、锌、镉、镍、钴杂质元素含量范围在本标准规定的测定范围。标准物质的引入和多家验证单位进行验证大大提高方法的准确性和可信度。

（三）标准预期的作用和效益

中国的锡储量占全球的28%，居第一位，与钨、锑、稀土并称为中国的四大战略资源，属于为数不多的中国可以具有定价能力的战略资源。

本项目是对GB/T 3260《锡化学分析方法》的补充完善，补充后的标准系列增加了对银、镍、钴的检测方法，扩大了检测范围，提高了其适用性。同时，ICP-AES方法12种杂质元素同时测定，能够大大缩短检测流程，提高检测效率，为贸易双方提供更好的用户体验。方法标准的形成能够更好的服务产品标准，为锡产品等级的划分提供方法依据，有助于产品质量提升，更好的推动产业发展，为生产企业带来可观的经济效益。同时，本标准的颁布实施有助于各检测机构实现标准化检测，提高数据的准确度。

六、采用国际标准和国外先进标准的情况

本文件为我国首次制定。经查，本文件与国内外现行标准及制定中的标准无重复交叉情况。本标准未采用（包括等同采用、修改采用及非等效采用）国际标准或国外先进标准。

七、与现行法律、法规、强制性国家标准及相关标准的关系

本标准属于锡化学分析方法标准，领域内没有强制性国家标准。本标准属于GB/T 3260《锡化学分析方法》标准系列的第12部分，是对标准系列的补充与完善。

本标准与现行法律、法规和相关标准相协调、无冲突。

八、重大分歧意见的处理和依据

无重大分歧。

九、标准作为强制性或推荐性国家（或行业）标准的建议

建议本标准为推荐性国家标准。

十、贯彻标准的要求和措施建议

本标准涉及锡产品中铜、铁、铋、铅、锑、砷、铝、锌、镉、镍、钴含量的同时测定，采用的设备为电感耦合等离子体发射光谱仪。该设备目前在各高校院所、企事业单位均具有较高的市场占有率。建议锡产品的生产单位及各大检测机构积极组织本标准的学习与宣贯，并向企业、公司和科研院校（所）推荐本标准。标准使用过程中出现疑问，标准的起草单位有义务进行必要的解释，可通过网络会议、讲座等形式进行标准内容的讲解。建议标准发布即实施。同时，标准要与时俱进，标准颁布实施后要定期进行复审，必要时启动修订程序。

十一、废止现行有关标准的建议

本标准为首次制定，不涉及相关标准的废止。

十二、其它应予说明的事项

无。

2023年2月

编制组

**附录A：各实验室原始数据**

表A.1 铜精密度试验原始数据

| 水平 | 实验室 | *w*Cu /% | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 0.00029 | 0.00028 | 0.00029 | 0.00028 | 0.00033 | 0.00030 | 0.00029 |
| 2 | 0.00029 | 0.00027 | 0.00026 | 0.00027 | 0.00026 | 0.00028 | 0.00028 |
| 3 | 0.00028 | 0.00029 | 0.00029 | 0.00030 | 0.00027 | 0.00027 | 0.00028 |
| 4 | 0.00028 | 0.00029 | 0.00029 | 0.00031 | 0.00030 | 0.00028 | 0.00029 |
| 5 | 0.00029 | 0.00030 | 0.00030 | 0.00030 | 0.00030 | 0.00033 | 0.00030 |
| 6 | 0.00031 | 0.00029 | 0.00031 | 0.00030 | 0.00034 | 0.00031 | 0.00031 |
| 7 | 0.00027 | 0.00028 | 0.00030 | 0.00029 | 0.00032 | 0.00027 | 0.00029 |
| 8 | 0.00027 | 0.00030 | 0.00025 | 0.00028 | 0.00028 | 0.00029 | 0.00029 |
| 9 | 0.00028 | 0.00029 | 0.00030 | 0.00030 | 0.00029 | 0.00027 | 0.00031 |
| 10 | 0.00030 | 0.00030 | 0.00033 | 0.00030 | 0.00032 | 0.00030 | 0.00031 |
| 11 | 0.00028 | 0.00029 | 0.00032 | 0.00030 | 0.00028 | 0.00032 | 0.00030 |
| 12 | 0.00033 | 0.00032 | 0.00032 | 0.00031 | 0.00029 | 0.00030 | 0.00029 |
| 13 | 0.00029 | 0.00030 | 0.00028 | 0.00032 | 0.00033 | 0.00031 | 0.00027 |
| 14 | 0.00030 | 0.00029 | 0.00033 | 0.00028 | 0.00031 | 0.00030 | 0.00030 |
| 15 | 0.00027 | 0.00028 | 0.00027 | 0.00029 | 0.00033 | 0.00032 | 0.00031 |
| 16 | 0.00031 | 0.00028 | 0.00031 | 0.00032 | 0.00032 | 0.00031 | 0.00030 |
| 17 | 0.00031 | 0.00030 | 0.00028 | 0.00029 | 0.00033 | 0.00031 | 0.00032 |
| 18 | 0.00031 | 0.00032 | 0.00028 | 0.00030 | 0.00030 | 0.00031 | 0.00028 |
| 2 | 1 | 0.00102 | 0.00110 | 0.00098 | 0.00104 | 0.00095 | 0.00103 | 0.00105 |
| 2 | 0.00101 | 0.00098 | 0.00097 | 0.00101 | 0.00103 | 0.00103 | 0.00104 |
| 3\* | 0.00097 | 0.00087 | 0.00086 | 0.00086 | 0.00088 | 0.00088 | 0.00088 |
| 4 | 0.00091 | 0.00098 | 0.00095 | 0.00098 | 0.00102 | 0.00105 | 0.00096 |
| 5 | 0.00103 | 0.00105 | 0.00102 | 0.00102 | 0.00103 | 0.00104 | 0.00104 |
| 6 | 0.00107 | 0.00102 | 0.00103 | 0.00093 | 0.00098 | 0.00102 | 0.00110 |
| 7 | 0.00100 | 0.00098 | 0.00096 | 0.00098 | 0.00096 | 0.00096 | 0.00099 |
| 8 | 0.00100 | 0.00105 | 0.00104 | 0.00103 | 0.00098 | 0.00101 | 0.00099 |
| 9 | 0.00102 | 0.00100 | 0.00104 | 0.00099 | 0.00101 | 0.00103 | 0.00101 |
| 10 | 0.00100 | 0.00101 | 0.00099 | 0.00099 | 0.00101 | 0.00100 | 0.00105 |
| 11 | 0.00095 | 0.00094 | 0.00097 | 0.00097 | 0.00096 | 0.00098 | 0.00101 |
| 12 | 0.00097 | 0.00101 | 0.00097 | 0.00104 | 0.00101 | 0.00096 | 0.00098 |
| 13 | 0.00101 | 0.00105 | 0.00097 | 0.00098 | 0.00103 | 0.00101 | 0.00105 |
| 14 | 0.00104 | 0.00110 | 0.00099 | 0.00104 | 0.00096 | 0.00103 | 0.00107 |
| 15 | 0.00099 | 0.00105 | 0.00097 | 0.00099 | 0.00095 | 0.00103 | 0.00105 |
| 16\* | 0.00111 | 0.00121 | 0.00142 | 0.00122 | 0.00114 | 0.00122 | 0.00132 |
| 17 | 0.00099 | 0.00103 | 0.00104 | 0.00101 | 0.00098 | 0.00096 | 0.00102 |
| 18 | 0.00108 | 0.00105 | 0.00105 | 0.00093 | 0.00097 | 0.00101 | 0.00104 |
| 3 | 1 | 0.00633 | 0.00630 | 0.00646 | 0.00651 | 0.00618 | 0.00641 | 0.00639 |
| 2\* | 0.00679 | 0.00667 | 0.00680 | 0.00673 | 0.00675 | 0.00644 | 0.00619 |
| 3 | 0.00627 | 0.00618 | 0.00632 | 0.00633 | 0.00631 | 0.00633 | 0.00602 |
| 4 | 0.00655 | 0.00643 | 0.00647 | 0.00639 | 0.00636 | 0.00633 | 0.00630 |
| 5\* | 0.00677 | 0.00667 | 0.00662 | 0.00685 | 0.00681 | 0.00676 | 0.00661 |
| 6 | 0.00638 | 0.00632 | 0.00617 | 0.00641 | 0.00646 | 0.00659 | 0.00629 |
| 7 | 0.00619 | 0.00633 | 0.00625 | 0.00658 | 0.00630 | 0.00642 | 0.00643 |
| 8 | 0.00637 | 0.00630 | 0.00636 | 0.00619 | 0.00627 | 0.00623 | 0.00629 |
| 9 | 0.00640 | 0.00637 | 0.00650 | 0.00645 | 0.00623 | 0.00636 | 0.00642 |
| 10 | 0.00631 | 0.00626 | 0.00621 | 0.00645 | 0.00631 | 0.00636 | 0.00638 |
| 11 | 0.00646 | 0.00639 | 0.00645 | 0.00641 | 0.00642 | 0.00651 | 0.00646 |
| 12 | 0.00629 | 0.00624 | 0.00626 | 0.00636 | 0.00624 | 0.00643 | 0.00636 |
| 13 | 0.00627 | 0.00625 | 0.00658 | 0.00635 | 0.00641 | 0.00638 | 0.00643 |
| 14 | 0.00635 | 0.00632 | 0.00647 | 0.00650 | 0.00617 | 0.00642 | 0.00629 |
| 15 | 0.00628 | 0.00629 | 0.00645 | 0.00667 | 0.00630 | 0.00622 | 0.00631 |
| 16 | 0.00631 | 0.00612 | 0.00644 | 0.00650 | 0.00653 | 0.00609 | 0.00618 |
| 17 | 0.00622 | 0.00635 | 0.00639 | 0.00638 | 0.00642 | 0.00640 | 0.00637 |
| 18 | 0.00618 | 0.00623 | 0.00631 | 0.00622 | 0.00628 | 0.00620 | 0.00633 |
| 4 | 1 | 0.0195 | 0.0198 | 0.0200 | 0.0201 | 0.0197 | 0.0203 | 0.0200 |
| 2\* | 0.0232 | 0.0215 | 0.0225 | 0.0230 | 0.0227 | 0.0216 | 0.0237 |
| 3 | 0.0190 | 0.0189 | 0.0191 | 0.0190 | 0.0190 | 0.0189 | 0.0190 |
| 4 | 0.0205 | 0.0195 | 0.0200 | 0.0203 | 0.0198 | 0.0199 | 0.0202 |
| 5 | 0.0202 | 0.0201 | 0.0200 | 0.0204 | 0.0204 | 0.0202 | 0.0203 |
| 6 | 0.0199 | 0.0198 | 0.0198 | 0.0197 | 0.0192 | 0.0191 | 0.0191 |
| 7 | 0.0194 | 0.0193 | 0.0191 | 0.0192 | 0.0196 | 0.0198 | 0.0201 |
| 8 | 0.0201 | 0.0200 | 0.0195 | 0.0200 | 0.0199 | 0.0204 | 0.0202 |
| 9 | 0.0198 | 0.0201 | 0.0197 | 0.0205 | 0.0200 | 0.0195 | 0.0196 |
| 10 | 0.0195 | 0.0195 | 0.0193 | 0.0195 | 0.0193 | 0.0195 | 0.0200 |
| 11 | 0.0201 | 0.0197 | 0.0197 | 0.0198 | 0.0199 | 0.0198 | 0.0200 |
| 12 | 0.0202 | 0.0203 | 0.0216 | 0.0214 | 0.0207 | 0.0215 | 0.0210 |
| 13 | 0.0202 | 0.0210 | 0.0203 | 0.0204 | 0.0204 | 0.0200 | 0.0196 |
| 14 | 0.0197 | 0.0198 | 0.0201 | 0.0201 | 0.0199 | 0.0203 | 0.0205 |
| 15 | 0.0203 | 0.0201 | 0.0197 | 0.0199 | 0.0202 | 0.0205 | 0.0196 |
| 16\* | 0.0234 | 0.0232 | 0.0224 | 0.0211 | 0.0213 | 0.0224 | 0.0220 |
| 17 | 0.0191 | 0.0202 | 0.0205 | 0.0195 | 0.0199 | 0.0201 | 0.0208 |
| 18 | 0.0202 | 0.0206 | 0.0204 | 0.0201 | 0.0202 | 0.0205 | 0.0204 |
| 5 | 1 | 0.0321 | 0.0328 | 0.0326 | 0.0324 | 0.0330 | 0.0326 | 0.0324 |
| 2 | 0.0347 | 0.0343 | 0.0351 | 0.0348 | 0.0345 | 0.0344 | 0.0354 |
| 3 | 0.0319 | 0.0318 | 0.0320 | 0.0321 | 0.0318 | 0.0319 | 0.0321 |
| 4 | 0.0331 | 0.0326 | 0.0329 | 0.0327 | 0.0327 | 0.0332 | 0.0324 |
| 5\* | 0.0360 | 0.0353 | 0.0362 | 0.0361 | 0.0360 | 0.0362 | 0.0357 |
| 6 | 0.0329 | 0.0329 | 0.0322 | 0.0323 | 0.0321 | 0.0321 | 0.0321 |
| 7 | 0.0331 | 0.0328 | 0.0329 | 0.0324 | 0.0324 | 0.0332 | 0.0326 |
| 8 | 0.0326 | 0.0322 | 0.0324 | 0.0331 | 0.0321 | 0.0333 | 0.0327 |
| 9 | 0.0328 | 0.0334 | 0.0339 | 0.0331 | 0.0331 | 0.0333 | 0.0335 |
| 10 | 0.0323 | 0.0328 | 0.0331 | 0.0335 | 0.0325 | 0.0325 | 0.0326 |
| 11 | 0.0338 | 0.0330 | 0.0337 | 0.0337 | 0.0338 | 0.0340 | 0.0331 |
| 12 | 0.0321 | 0.0323 | 0.0322 | 0.0331 | 0.0320 | 0.0320 | 0.0325 |
| 13 | 0.0327 | 0.0334 | 0.0321 | 0.0323 | 0.0328 | 0.0331 | 0.0325 |
| 14 | 0.0322 | 0.0329 | 0.0325 | 0.0320 | 0.0331 | 0.0327 | 0.0334 |
| 15 | 0.0311 | 0.0317 | 0.0328 | 0.0320 | 0.0328 | 0.0332 | 0.0327 |
| 16 | 0.0328 | 0.0343 | 0.0331 | 0.0335 | 0.0342 | 0.0329 | 0.0331 |
| 17 | 0.0332 | 0.0335 | 0.0340 | 0.0331 | 0.0327 | 0.0335 | 0.0337 |
| 18 | 0.0330 | 0.0333 | 0.0329 | 0.0333 | 0.0326 | 0.0320 | 0.0320 |
| 6 | 1 | 0.0444 | 0.0441 | 0.0451 | 0.0456 | 0.0460 | 0.0459 | 0.0454 |
| 2 | 0.0451 | 0.0442 | 0.0466 | 0.0447 | 0.0452 | 0.0452 | 0.0440 |
| 3 | 0.0453 | 0.0455 | 0.0458 | 0.0454 | 0.0455 | 0.0458 | 0.0457 |
| 4 | 0.0446 | 0.0453 | 0.0442 | 0.0451 | 0.0448 | 0.0459 | 0.0456 |
| 5 | 0.0459 | 0.0458 | 0.0464 | 0.0470 | 0.0459 | 0.0462 | 0.0463 |
| 6 | 0.0452 | 0.0452 | 0.0452 | 0.0442 | 0.0443 | 0.0459 | 0.0459 |
| 7 | 0.0459 | 0.0461 | 0.0453 | 0.0460 | 0.0441 | 0.0460 | 0.0449 |
| 8 | 0.0455 | 0.0451 | 0.0450 | 0.0462 | 0.0452 | 0.0457 | 0.0449 |
| 9 | 0.0453 | 0.0452 | 0.0453 | 0.0456 | 0.0466 | 0.0450 | 0.0456 |
| 10 | 0.0448 | 0.0450 | 0.0458 | 0.0449 | 0.0457 | 0.0448 | 0.0446 |
| 11 | 0.0445 | 0.0447 | 0.0453 | 0.0452 | 0.0456 | 0.0456 | 0.0455 |
| 12 | 0.0450 | 0.0449 | 0.0454 | 0.0453 | 0.0461 | 0.0462 | 0.0458 |
| 13 | 0.0453 | 0.0459 | 0.0443 | 0.0448 | 0.0439 | 0.0455 | 0.0452 |
| 14 | 0.0446 | 0.0445 | 0.0442 | 0.0458 | 0.0460 | 0.0462 | 0.0455 |
| 15 | 0.0446 | 0.0451 | 0.0443 | 0.0444 | 0.0452 | 0.0453 | 0.0454 |
| 16\* | 0.0462 | 0.0481 | 0.0491 | 0.0492 | 0.0483 | 0.0494 | 0.0522 |
| 17 | 0.0431 | 0.0438 | 0.0442 | 0.0433 | 0.0446 | 0.0449 | 0.0442 |
| 18 | 0.0449 | 0.0448 | 0.0450 | 0.0456 | 0.0448 | 0.0446 | 0.0453 |

表A.2 铁精密度试验原始数据

| 水平 | 实验室 | *w*Fe /% | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 0.00030 | 0.00030 | 0.00031 | 0.00034 | 0.00029 | 0.00029 | 0.00031 |
| 2 | 0.00028 | 0.00036 | 0.00035 | 0.00035 | 0.00034 | 0.00034 | 0.00034 |
| 3 | 0.00031 | 0.00030 | 0.00029 | 0.00032 | 0.00029 | 0.00029 | 0.00032 |
| 4 | 0.00028 | 0.00030 | 0.00031 | 0.00032 | 0.00028 | 0.00029 | 0.00031 |
| 5 | 0.00027 | 0.00029 | 0.00026 | 0.00026 | 0.00024 | 0.00029 | 0.00025 |
| 6 | 0.00031 | 0.00031 | 0.00032 | 0.00029 | 0.00033 | 0.00031 | 0.00033 |
| 7 | 0.00028 | 0.00031 | 0.00030 | 0.00027 | 0.00028 | 0.00029 | 0.00031 |
| 8 | 0.00030 | 0.00029 | 0.00032 | 0.00030 | 0.00030 | 0.00032 | 0.00031 |
| 9 | 0.00031 | 0.00030 | 0.00031 | 0.00031 | 0.00030 | 0.00032 | 0.00028 |
| 10 | 0.00030 | 0.00028 | 0.00031 | 0.00029 | 0.00030 | 0.00029 | 0.00030 |
| 11 | 0.00034 | 0.00028 | 0.00029 | 0.00033 | 0.00034 | 0.00032 | 0.00032 |
| 12 | 0.00031 | 0.00031 | 0.00030 | 0.00030 | 0.00032 | 0.00031 | 0.00030 |
| 13 | 0.00030 | 0.00028 | 0.00032 | 0.00033 | 0.00028 | 0.00028 | 0.00030 |
| 14 | 0.00031 | 0.00033 | 0.00033 | 0.00029 | 0.00027 | 0.00030 | 0.00032 |
| 15 | 0.00029 | 0.00030 | 0.00032 | 0.00033 | 0.00031 | 0.00030 | 0.00032 |
| 16\* | 0.00041 | 0.00036 | 0.00041 | 0.00041 | 0.00038 | 0.00042 | 0.00041 |
| 17 | 0.00029 | 0.00028 | 0.00028 | 0.00030 | 0.00029 | 0.00030 | 0.00028 |
| 18 | 0.00032 | 0.00027 | 0.00029 | 0.00031 | 0.00028 | 0.00028 | 0.00030 |
| 2 | 1 | 0.00100 | 0.00096 | 0.00103 | 0.00111 | 0.00105 | 0.00104 | 0.00097 |
| 2 | 0.00109 | 0.00106 | 0.00104 | 0.00107 | 0.00111 | 0.00111 | 0.00109 |
| 3 | 0.00095 | 0.00098 | 0.00103 | 0.00115 | 0.00105 | 0.00109 | 0.00099 |
| 4 | 0.00100 | 0.00096 | 0.00095 | 0.00099 | 0.00103 | 0.00109 | 0.00106 |
| 5 | 0.00097 | 0.00106 | 0.00090 | 0.00093 | 0.00096 | 0.00099 | 0.00095 |
| 6 | 0.00100 | 0.00096 | 0.00101 | 0.00100 | 0.00099 | 0.00107 | 0.00097 |
| 7 | 0.00095 | 0.00097 | 0.00096 | 0.00097 | 0.00098 | 0.00097 | 0.00098 |
| 8 | 0.00101 | 0.00104 | 0.00097 | 0.00100 | 0.00102 | 0.00100 | 0.00101 |
| 9 | 0.00099 | 0.00103 | 0.00103 | 0.00102 | 0.00101 | 0.00102 | 0.00101 |
| 10 | 0.00106 | 0.00103 | 0.00106 | 0.00103 | 0.00106 | 0.00103 | 0.00103 |
| 11 | 0.00098 | 0.00102 | 0.00095 | 0.00094 | 0.00098 | 0.00096 | 0.00091 |
| 12 | 0.00106 | 0.00101 | 0.00106 | 0.00092 | 0.00102 | 0.00105 | 0.00099 |
| 13 | 0.00109 | 0.00102 | 0.00098 | 0.00100 | 0.00103 | 0.00102 | 0.00095 |
| 14 | 0.00102 | 0.00097 | 0.00103 | 0.00109 | 0.00105 | 0.00108 | 0.00099 |
| 15 | 0.00105 | 0.00097 | 0.00104 | 0.00111 | 0.00103 | 0.00105 | 0.00099 |
| 16\* | 0.00152 | 0.00142 | 0.00144 | 0.00161 | 0.00152 | 0.00154 | 0.00165 |
| 17 | 0.00108 | 0.00106 | 0.00105 | 0.00100 | 0.00104 | 0.00102 | 0.00105 |
| 18 | 0.00093 | 0.00094 | 0.00098 | 0.00096 | 0.00103 | 0.00102 | 0.00098 |
| 3 | 1 | 0.00321 | 0.00329 | 0.00321 | 0.00334 | 0.00342 | 0.00323 | 0.00344 |
| 2 | 0.00342 | 0.00313 | 0.00319 | 0.00321 | 0.00334 | 0.00326 | 0.00317 |
| 3 | 0.00331 | 0.00329 | 0.00331 | 0.00344 | 0.00342 | 0.00323 | 0.00334 |
| 4 | 0.00321 | 0.00331 | 0.00328 | 0.00329 | 0.00335 | 0.00346 | 0.00336 |
| 5\* | 0.00236 | 0.00181 | 0.00205 | 0.00187 | 0.00234 | 0.00169 | 0.00181 |
| 6 | 0.00345 | 0.00329 | 0.00343 | 0.00331 | 0.00327 | 0.00322 | 0.00322 |
| 7 | 0.00335 | 0.00326 | 0.00341 | 0.00324 | 0.00349 | 0.00347 | 0.00350 |
| 8 | 0.00342 | 0.00341 | 0.00343 | 0.00337 | 0.00332 | 0.00340 | 0.00339 |
| 9 | 0.00331 | 0.00330 | 0.00331 | 0.00334 | 0.00327 | 0.00329 | 0.00329 |
| 10 | 0.00335 | 0.00338 | 0.00339 | 0.00349 | 0.00333 | 0.00339 | 0.00331 |
| 11 | 0.00357 | 0.00350 | 0.00352 | 0.00346 | 0.00343 | 0.00363 | 0.00357 |
| 12 | 0.00329 | 0.00326 | 0.00339 | 0.00318 | 0.00321 | 0.00324 | 0.00319 |
| 13 | 0.00351 | 0.00346 | 0.00369 | 0.00372 | 0.00362 | 0.00351 | 0.00358 |
| 14 | 0.00324 | 0.00326 | 0.00323 | 0.00332 | 0.00340 | 0.00326 | 0.00343 |
| 15 | 0.00333 | 0.00328 | 0.00342 | 0.00355 | 0.00329 | 0.00337 | 0.00340 |
| 16 | 0.00352 | 0.00364 | 0.00382 | 0.00364 | 0.00395 | 0.00392 | 0.00383 |
| 17 | 0.00314 | 0.00322 | 0.00320 | 0.00312 | 0.00323 | 0.00318 | 0.00319 |
| 18 | 0.00318 | 0.00325 | 0.00323 | 0.00330 | 0.00319 | 0.00322 | 0.00328 |
| 4 | 1 | 0.00877 | 0.00871 | 0.00888 | 0.00878 | 0.00881 | 0.00895 | 0.00871 |
| 2 | 0.00840 | 0.00858 | 0.00845 | 0.00844 | 0.00861 | 0.00849 | 0.00849 |
| 3 | 0.00935 | 0.00907 | 0.00910 | 0.00894 | 0.00900 | 0.00904 | 0.00914 |
| 4 | 0.00867 | 0.00871 | 0.00880 | 0.00868 | 0.00873 | 0.00886 | 0.00895 |
| 5\* | 0.00700 | 0.00704 | 0.00687 | 0.00694 | 0.00683 | 0.00684 | 0.00699 |
| 6 | 0.00886 | 0.00876 | 0.00873 | 0.00894 | 0.00876 | 0.00887 | 0.00888 |
| 7\* | 0.00812 | 0.00836 | 0.00829 | 0.00867 | 0.00872 | 0.00839 | 0.00881 |
| 8 | 0.00883 | 0.00889 | 0.00878 | 0.00873 | 0.00875 | 0.00882 | 0.00885 |
| 9 | 0.00887 | 0.00886 | 0.00876 | 0.00891 | 0.00874 | 0.00866 | 0.00878 |
| 10 | 0.00893 | 0.00889 | 0.00902 | 0.00880 | 0.00890 | 0.00901 | 0.00890 |
| 11 | 0.00895 | 0.00870 | 0.00875 | 0.00871 | 0.00882 | 0.00889 | 0.00892 |
| 12 | 0.00887 | 0.00886 | 0.00881 | 0.00887 | 0.00882 | 0.00883 | 0.00888 |
| 13 | 0.00898 | 0.00890 | 0.00870 | 0.00881 | 0.00871 | 0.00876 | 0.00882 |
| 14 | 0.00887 | 0.00871 | 0.00878 | 0.00878 | 0.00883 | 0.00891 | 0.00871 |
| 15\* | 0.00822 | 0.00830 | 0.00813 | 0.00823 | 0.00822 | 0.00830 | 0.00827 |
| 16\* | 0.00924 | 0.00941 | 0.00902 | 0.00922 | 0.00951 | 0.00964 | 0.00973 |
| 17 | 0.00881 | 0.00885 | 0.00880 | 0.00875 | 0.00880 | 0.00884 | 0.00887 |
| 18 | 0.00878 | 0.00872 | 0.00881 | 0.00870 | 0.00868 | 0.00877 | 0.00878 |
| 5 | 1 | 0.0200 | 0.0194 | 0.0201 | 0.0206 | 0.0197 | 0.0203 | 0.0205 |
| 2 | 0.0232 | 0.0220 | 0.0206 | 0.0209 | 0.0214 | 0.0215 | 0.0216 |
| 3 | 0.0198 | 0.0194 | 0.0196 | 0.0192 | 0.0196 | 0.0194 | 0.0198 |
| 4 | 0.0206 | 0.0195 | 0.0197 | 0.0192 | 0.0204 | 0.0203 | 0.0202 |
| 5 | 0.0184 | 0.0184 | 0.0182 | 0.0186 | 0.0183 | 0.0180 | 0.0180 |
| 6 | 0.0207 | 0.0207 | 0.0193 | 0.0193 | 0.0208 | 0.0208 | 0.0208 |
| 7 | 0.0215 | 0.0216 | 0.0206 | 0.0207 | 0.0200 | 0.0201 | 0.0208 |
| 8 | 0.0205 | 0.0207 | 0.0200 | 0.0197 | 0.0204 | 0.0206 | 0.0200 |
| 9 | 0.0199 | 0.0203 | 0.0201 | 0.0202 | 0.0199 | 0.0204 | 0.0200 |
| 10 | 0.0195 | 0.0195 | 0.0195 | 0.0196 | 0.0198 | 0.0197 | 0.0199 |
| 11 | 0.0206 | 0.0195 | 0.0200 | 0.0197 | 0.0196 | 0.0198 | 0.0199 |
| 12 | 0.0206 | 0.0205 | 0.0212 | 0.0213 | 0.0209 | 0.0211 | 0.0208 |
| 13 | 0.0211 | 0.0204 | 0.0212 | 0.0209 | 0.0210 | 0.0201 | 0.0197 |
| 14 | 0.0201 | 0.0194 | 0.0200 | 0.0207 | 0.0199 | 0.0205 | 0.0205 |
| 15 | 0.0205 | 0.0195 | 0.0197 | 0.0203 | 0.0207 | 0.0196 | 0.0195 |
| 16\* | 0.0250 | 0.0240 | 0.0230 | 0.0250 | 0.0240 | 0.0230 | 0.0250 |
| 17 | 0.0211 | 0.0214 | 0.0205 | 0.0199 | 0.0204 | 0.0206 | 0.0197 |
| 18 | 0.0198 | 0.0196 | 0.0196 | 0.0210 | 0.0207 | 0.0200 | 0.0198 |
| 6 | 1 | 0.0451 | 0.0448 | 0.0452 | 0.0451 | 0.0447 | 0.0455 | 0.0446 |
| 2 | 0.0462 | 0.0442 | 0.0457 | 0.0457 | 0.0461 | 0.0450 | 0.0453 |
| 3\* | 0.0432 | 0.0422 | 0.0440 | 0.0436 | 0.0438 | 0.0423 | 0.0433 |
| 4 | 0.0447 | 0.0448 | 0.0441 | 0.0449 | 0.0442 | 0.0451 | 0.0455 |
| 5\* | 0.0413 | 0.0410 | 0.0415 | 0.0420 | 0.0408 | 0.0411 | 0.0412 |
| 6 | 0.0451 | 0.0445 | 0.0447 | 0.0457 | 0.0452 | 0.0447 | 0.0443 |
| 7 | 0.0459 | 0.0461 | 0.0462 | 0.0457 | 0.0452 | 0.0463 | 0.0465 |
| 8 | 0.0448 | 0.0448 | 0.0452 | 0.0457 | 0.0445 | 0.0450 | 0.0459 |
| 9 | 0.0454 | 0.0457 | 0.0454 | 0.0453 | 0.0465 | 0.0454 | 0.0454 |
| 10 | 0.0444 | 0.0446 | 0.0450 | 0.0440 | 0.0440 | 0.0451 | 0.0452 |
| 11 | 0.0447 | 0.0443 | 0.0440 | 0.0450 | 0.0452 | 0.0449 | 0.0453 |
| 12 | 0.0440 | 0.0440 | 0.0442 | 0.0435 | 0.0442 | 0.0456 | 0.0464 |
| 13 | 0.0442 | 0.0463 | 0.0454 | 0.0450 | 0.0449 | 0.0456 | 0.0458 |
| 14 | 0.0455 | 0.0458 | 0.0430 | 0.0454 | 0.0447 | 0.0445 | 0.0449 |
| 15\* | 0.0453 | 0.0456 | 0.0461 | 0.0454 | 0.0449 | 0.0450 | 0.0454 |
| 16 | 0.0522 | 0.0532 | 0.0541 | 0.0554 | 0.0582 | 0.0553 | 0.0571 |
| 17 | 0.0452 | 0.0450 | 0.0458 | 0.0461 | 0.0455 | 0.0436 | 0.0447 |
| 18 | 0.0455 | 0.0458 | 0.0454 | 0.0451 | 0.0448 | 0.0455 | 0.0460 |

表A.3 铋精密度试验原始数据

| 水平 | 实验室 | *w*Bi /% | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 0.00191 | 0.00192 | 0.00192 | 0.00201 | 0.00191 | 0.00186 | 0.00197 |
| 2 | 0.00214 | 0.00216 | 0.00216 | 0.00220 | 0.00214 | 0.00220 | 0.00226 |
| 3\* | 0.00204 | 0.00200 | 0.00200 | 0.00194 | 0.00204 | 0.00174 | 0.00196 |
| 4 | 0.00208 | 0.00201 | 0.00201 | 0.00212 | 0.00208 | 0.00206 | 0.00198 |
| 5 | 0.00209 | 0.00221 | 0.00221 | 0.00208 | 0.00209 | 0.00212 | 0.00217 |
| 6 | 0.00195 | 0.00197 | 0.00197 | 0.00204 | 0.00195 | 0.00197 | 0.00191 |
| 7 | 0.00196 | 0.00193 | 0.00193 | 0.00200 | 0.00196 | 0.00192 | 0.00190 |
| 8 | 0.00202 | 0.00195 | 0.00195 | 0.00196 | 0.00202 | 0.00198 | 0.00189 |
| 9 | 0.00203 | 0.00205 | 0.00205 | 0.00201 | 0.00203 | 0.00201 | 0.00206 |
| 10 | 0.00200 | 0.00205 | 0.00205 | 0.00201 | 0.00200 | 0.00199 | 0.00196 |
| 11 | 0.00199 | 0.00194 | 0.00194 | 0.00195 | 0.00199 | 0.00197 | 0.00195 |
| 12 | 0.00200 | 0.00203 | 0.00203 | 0.00198 | 0.00200 | 0.00196 | 0.00191 |
| 13 | 0.00190 | 0.00185 | 0.00185 | 0.00189 | 0.00190 | 0.00195 | 0.00196 |
| 14 | 0.00194 | 0.00196 | 0.00196 | 0.00188 | 0.00194 | 0.00204 | 0.00199 |
| 15 | 0.00193 | 0.00195 | 0.00195 | 0.00204 | 0.00193 | 0.00189 | 0.00201 |
| 16\* | 0.00188 | 0.00164 | 0.00164 | 0.00165 | 0.00188 | 0.00172 | 0.00174 |
| 17 | 0.00201 | 0.00198 | 0.00198 | 0.00196 | 0.00201 | 0.00199 | 0.00195 |
| 18 | 0.00189 | 0.00197 | 0.00197 | 0.00195 | 0.00189 | 0.00199 | 0.00188 |
| 2 | 1 | 0.00653 | 0.00682 | 0.00678 | 0.00681 | 0.00668 | 0.00646 | 0.00660 |
| 2\* | 0.00583 | 0.00591 | 0.00592 | 0.00574 | 0.00580 | 0.00546 | 0.00530 |
| 3\* | 0.00594 | 0.00595 | 0.00596 | 0.00592 | 0.00599 | 0.00597 | 0.00606 |
| 4 | 0.00672 | 0.00681 | 0.00693 | 0.00673 | 0.00660 | 0.00655 | 0.00661 |
| 6 | 0.00662 | 0.00680 | 0.00669 | 0.00683 | 0.00668 | 0.00660 | 0.00661 |
| 7 | 0.00670 | 0.00658 | 0.00672 | 0.00669 | 0.00651 | 0.00679 | 0.00659 |
| 8 | 0.00666 | 0.00674 | 0.00661 | 0.00666 | 0.00655 | 0.00673 | 0.00661 |
| 9 | 0.00659 | 0.00674 | 0.00672 | 0.00656 | 0.00678 | 0.00668 | 0.00660 |
| 10 | 0.00659 | 0.00677 | 0.00668 | 0.00677 | 0.00675 | 0.00671 | 0.00670 |
| 11 | 0.00665 | 0.00665 | 0.00667 | 0.00668 | 0.00664 | 0.00665 | 0.00669 |
| 12 | 0.00681 | 0.00679 | 0.00680 | 0.00673 | 0.00673 | 0.00670 | 0.00676 |
| 13 | 0.00639 | 0.00666 | 0.00700 | 0.00646 | 0.00659 | 0.00689 | 0.00632 |
| 14 | 0.00654 | 0.00682 | 0.00679 | 0.00681 | 0.00678 | 0.00646 | 0.00660 |
| 15 | 0.00625 | 0.00638 | 0.00599 | 0.00597 | 0.00603 | 0.00599 | 0.00596 |
| 16\* | 0.00625 | 0.00574 | 0.00582 | 0.00563 | 0.00608 | 0.00584 | 0.00611 |
| 17 | 0.00625 | 0.00677 | 0.00670 | 0.00667 | 0.00680 | 0.00677 | 0.00662 |
| 18 | 0.00625 | 0.00701 | 0.00686 | 0.00678 | 0.00668 | 0.00661 | 0.00672 |
| 3 | 1 | 0.0143 | 0.0136 | 0.0142 | 0.0139 | 0.0146 | 0.0147 | 0.0142 |
| 2 | 0.0156 | 0.0155 | 0.0154 | 0.0154 | 0.0155 | 0.0154 | 0.0154 |
| 3 | 0.0141 | 0.0142 | 0.0144 | 0.0141 | 0.0142 | 0.0141 | 0.0139 |
| 4 | 0.0141 | 0.0145 | 0.0142 | 0.0138 | 0.0146 | 0.0147 | 0.0144 |
| 5\* | 0.0067 | 0.0067 | 0.0069 | 0.0069 | 0.0070 | 0.0070 | 0.0071 |
| 6 | 0.0147 | 0.0139 | 0.0140 | 0.0137 | 0.0139 | 0.0140 | 0.0138 |
| 7 | 0.0143 | 0.0144 | 0.0142 | 0.0145 | 0.0147 | 0.0149 | 0.0145 |
| 8 | 0.0140 | 0.0145 | 0.0143 | 0.0141 | 0.0143 | 0.0146 | 0.0144 |
| 9 | 0.0144 | 0.0143 | 0.0144 | 0.0145 | 0.0144 | 0.0145 | 0.0144 |
| 10 | 0.0143 | 0.0142 | 0.0145 | 0.0141 | 0.0143 | 0.0142 | 0.0141 |
| 11 | 0.0144 | 0.0144 | 0.0145 | 0.0144 | 0.0142 | 0.0144 | 0.0141 |
| 12 | 0.0134 | 0.0138 | 0.0132 | 0.0140 | 0.0147 | 0.0142 | 0.0143 |
| 13 | 0.0147 | 0.0139 | 0.0144 | 0.0145 | 0.0142 | 0.0138 | 0.0146 |
| 14 | 0.0144 | 0.0138 | 0.0140 | 0.0139 | 0.0145 | 0.0147 | 0.0143 |
| 15 | 0.0148 | 0.0145 | 0.0142 | 0.0143 | 0.0146 | 0.0143 | 0.0144 |
| 16 | 0.0132 | 0.0141 | 0.0134 | 0.0132 | 0.0123 | 0.0134 | 0.0132 |
| 17 | 0.0138 | 0.0139 | 0.0140 | 0.0144 | 0.0140 | 0.0139 | 0.0137 |
| 18 | 0.0145 | 0.0138 | 0.0143 | 0.0142 | 0.0141 | 0.0144 | 0.0143 |
| 4 | 1 | 0.0248 | 0.0249 | 0.0250 | 0.0247 | 0.0238 | 0.0244 | 0.0243 |
| 2 | 0.0263 | 0.0261 | 0.0261 | 0.0258 | 0.0263 | 0.0258 | 0.0257 |
| 3 | 0.0232 | 0.0233 | 0.0230 | 0.0229 | 0.0226 | 0.0228 | 0.0231 |
| 4 | 0.0248 | 0.0245 | 0.0244 | 0.0242 | 0.0251 | 0.0246 | 0.0241 |
| 5\* | 0.0164 | 0.0167 | 0.0169 | 0.0167 | 0.0165 | 0.0167 | 0.0164 |
| 6 | 0.0240 | 0.0244 | 0.0242 | 0.0244 | 0.0241 | 0.0245 | 0.0243 |
| 7 | 0.0251 | 0.0251 | 0.0253 | 0.0254 | 0.0252 | 0.0251 | 0.0250 |
| 8 | 0.0250 | 0.0245 | 0.0250 | 0.0245 | 0.0249 | 0.0247 | 0.0245 |
| 9 | 0.0252 | 0.0246 | 0.0252 | 0.0250 | 0.0252 | 0.0248 | 0.0251 |
| 10 | 0.0245 | 0.0244 | 0.0246 | 0.0247 | 0.0243 | 0.0242 | 0.0245 |
| 11 | 0.0245 | 0.0246 | 0.0238 | 0.0244 | 0.0245 | 0.0239 | 0.0243 |
| 12 | 0.0242 | 0.0229 | 0.0249 | 0.0250 | 0.0243 | 0.0238 | 0.0249 |
| 13 | 0.0245 | 0.0241 | 0.0240 | 0.0258 | 0.0249 | 0.0242 | 0.0246 |
| 14 | 0.0244 | 0.0249 | 0.0250 | 0.0249 | 0.0239 | 0.0244 | 0.0242 |
| 15 | 0.0221 | 0.0212 | 0.0222 | 0.0212 | 0.0225 | 0.0232 | 0.0227 |
| 16\* | 0.0231 | 0.0232 | 0.0224 | 0.0223 | 0.0233 | 0.0221 | 0.0205 |
| 17 | 0.0245 | 0.0242 | 0.0240 | 0.0249 | 0.0250 | 0.0247 | 0.0246 |
| 18 | 0.0238 | 0.0244 | 0.0241 | 0.0240 | 0.0238 | 0.0246 | 0.0246 |
| 5 | 1 | 0.0486 | 0.0485 | 0.0495 | 0.0485 | 0.0493 | 0.0489 | 0.0497 |
| 2\* | 0.0453 | 0.0442 | 0.0451 | 0.0496 | 0.0444 | 0.0441 | 0.0438 |
| 4 | 0.0486 | 0.0489 | 0.0492 | 0.0473 | 0.0488 | 0.0480 | 0.0483 |
| 6 | 0.0488 | 0.0491 | 0.0492 | 0.0486 | 0.0486 | 0.0499 | 0.0479 |
| 7 | 0.0492 | 0.0489 | 0.0495 | 0.0483 | 0.0486 | 0.0493 | 0.0489 |
| 8 | 0.0489 | 0.0486 | 0.0488 | 0.0483 | 0.0493 | 0.0495 | 0.0489 |
| 9 | 0.0482 | 0.0487 | 0.0484 | 0.0483 | 0.0484 | 0.0486 | 0.0490 |
| 10 | 0.0502 | 0.0509 | 0.0499 | 0.0498 | 0.0495 | 0.0502 | 0.0504 |
| 12 | 0.0478 | 0.0487 | 0.0480 | 0.0482 | 0.0481 | 0.0478 | 0.0489 |
| 13 | 0.0483 | 0.0480 | 0.0479 | 0.0483 | 0.0489 | 0.0484 | 0.0486 |
| 14 | 0.0485 | 0.0477 | 0.0495 | 0.0485 | 0.0495 | 0.0492 | 0.0501 |
| 15 | 0.0490 | 0.0496 | 0.0493 | 0.0487 | 0.0497 | 0.0490 | 0.0493 |
| 16\* | 0.0444 | 0.0452 | 0.0443 | 0.0454 | 0.0422 | 0.0414 | 0.0447 |
| 17 | 0.0502 | 0.0493 | 0.0478 | 0.0498 | 0.0501 | 0.0485 | 0.0492 |
| 18 | 0.0488 | 0.0481 | 0.0479 | 0.0484 | 0.0482 | 0.0487 | 0.0492 |

表A.4 铅精密度试验原始数据

| 水平 | 实验室 | *w*Pb /% | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 0.00194 | 0.00200 | 0.00205 | 0.00211 | 0.00207 | 0.00212 | 0.00208 |
| 2 | 0.00214 | 0.00215 | 0.00207 | 0.00199 | 0.00219 | 0.00208 | 0.00200 |
| 3 | 0.00191 | 0.00194 | 0.00193 | 0.00195 | 0.00195 | 0.00197 | 0.00195 |
| 4 | 0.00197 | 0.00200 | 0.00194 | 0.00207 | 0.00198 | 0.00211 | 0.00206 |
| 5 | 0.00198 | 0.00198 | 0.00193 | 0.00191 | 0.00192 | 0.00193 | 0.00190 |
| 6 | 0.00202 | 0.00208 | 0.00196 | 0.00200 | 0.00192 | 0.00205 | 0.00202 |
| 7 | 0.00202 | 0.00198 | 0.00197 | 0.00205 | 0.00196 | 0.00189 | 0.00197 |
| 8 | 0.00212 | 0.00215 | 0.00190 | 0.00204 | 0.00201 | 0.00213 | 0.00206 |
| 9 | 0.00206 | 0.00202 | 0.00203 | 0.00212 | 0.00211 | 0.00195 | 0.00206 |
| 10 | 0.00201 | 0.00204 | 0.00202 | 0.00201 | 0.00203 | 0.00204 | 0.00205 |
| 11 | 0.00189 | 0.00194 | 0.00198 | 0.00192 | 0.00196 | 0.00200 | 0.00197 |
| 12 | 0.00191 | 0.00201 | 0.00197 | 0.00206 | 0.00196 | 0.00196 | 0.00199 |
| 13 | 0.00198 | 0.00190 | 0.00201 | 0.00199 | 0.00203 | 0.00195 | 0.00194 |
| 14 | 0.00198 | 0.00200 | 0.00207 | 0.00207 | 0.00214 | 0.00212 | 0.00213 |
| 15 | 0.00199 | 0.00202 | 0.00203 | 0.00208 | 0.00188 | 0.00210 | 0.00205 |
| 16 | 0.00214 | 0.00213 | 0.00214 | 0.00212 | 0.00211 | 0.00211 | 0.00213 |
| 17 | 0.00190 | 0.00199 | 0.00194 | 0.00198 | 0.00201 | 0.00201 | 0.00198 |
| 18 | 0.00198 | 0.00196 | 0.00188 | 0.00198 | 0.00203 | 0.00202 | 0.00198 |
| 2 | 1 | 0.00512 | 0.00508 | 0.00504 | 0.00495 | 0.00499 | 0.00511 | 0.00506 |
| 2 | 0.00512 | 0.00503 | 0.00494 | 0.00520 | 0.00492 | 0.00485 | 0.00493 |
| 3 | 0.00483 | 0.00475 | 0.00477 | 0.00481 | 0.00485 | 0.00485 | 0.00497 |
| 4 | 0.00505 | 0.00508 | 0.00501 | 0.00510 | 0.00495 | 0.00493 | 0.00508 |
| 5 | 0.00486 | 0.00492 | 0.00482 | 0.00481 | 0.00484 | 0.00483 | 0.00479 |
| 6 | 0.00510 | 0.00498 | 0.00503 | 0.00495 | 0.00508 | 0.00509 | 0.00496 |
| 7 | 0.00491 | 0.00494 | 0.00490 | 0.00494 | 0.00492 | 0.00501 | 0.00499 |
| 8 | 0.00506 | 0.00502 | 0.00495 | 0.00492 | 0.00513 | 0.00511 | 0.00509 |
| 9 | 0.00502 | 0.00515 | 0.00514 | 0.00504 | 0.00503 | 0.00504 | 0.00508 |
| 10 | 0.00504 | 0.00502 | 0.00501 | 0.00499 | 0.00498 | 0.00502 | 0.00503 |
| 11 | 0.00487 | 0.00492 | 0.00501 | 0.00494 | 0.00496 | 0.00503 | 0.00498 |
| 12 | 0.00526 | 0.00508 | 0.00528 | 0.00498 | 0.00499 | 0.00525 | 0.00503 |
| 13 | 0.00504 | 0.00506 | 0.00502 | 0.00499 | 0.00504 | 0.00510 | 0.00502 |
| 14 | 0.00509 | 0.00506 | 0.00509 | 0.00498 | 0.00497 | 0.00513 | 0.00507 |
| 15 | 0.00502 | 0.00510 | 0.00509 | 0.00492 | 0.00496 | 0.00508 | 0.00505 |
| 16\* | 0.00521 | 0.00542 | 0.00555 | 0.00538 | 0.00547 | 0.00532 | 0.00554 |
| 17 | 0.00515 | 0.00510 | 0.00494 | 0.00505 | 0.00498 | 0.00502 | 0.00500 |
| 18 | 0.00494 | 0.00497 | 0.00501 | 0.00496 | 0.00491 | 0.00508 | 0.00508 |
| 3 | 1 | 0.00848 | 0.00855 | 0.00839 | 0.00872 | 0.00868 | 0.00861 | 0.00846 |
| 2 | 0.00876 | 0.00860 | 0.00844 | 0.00851 | 0.00868 | 0.00859 | 0.00859 |
| 3 | 0.00843 | 0.00840 | 0.00850 | 0.00835 | 0.00835 | 0.00845 | 0.00831 |
| 4 | 0.00848 | 0.00833 | 0.00857 | 0.00866 | 0.00842 | 0.00868 | 0.00862 |
| 5\* | 0.00605 | 0.00587 | 0.00595 | 0.00590 | 0.00586 | 0.00585 | 0.00586 |
| 6 | 0.00867 | 0.00846 | 0.00865 | 0.00853 | 0.00863 | 0.00868 | 0.00858 |
| 7 | 0.00848 | 0.00841 | 0.00854 | 0.00832 | 0.00849 | 0.00862 | 0.00876 |
| 8 | 0.00847 | 0.00858 | 0.00844 | 0.00841 | 0.00857 | 0.00860 | 0.00860 |
| 9 | 0.00855 | 0.00858 | 0.00864 | 0.00861 | 0.00861 | 0.00860 | 0.00856 |
| 10 | 0.00854 | 0.00851 | 0.00864 | 0.00865 | 0.00859 | 0.00861 | 0.00862 |
| 11 | 0.00869 | 0.00860 | 0.00865 | 0.00867 | 0.00863 | 0.00864 | 0.00862 |
| 12 | 0.00842 | 0.00846 | 0.00849 | 0.00867 | 0.00860 | 0.00861 | 0.00862 |
| 13 | 0.00840 | 0.00879 | 0.00855 | 0.00865 | 0.00849 | 0.00872 | 0.00854 |
| 14 | 0.00858 | 0.00855 | 0.00849 | 0.00872 | 0.00868 | 0.00861 | 0.00856 |
| 15 | 0.00865 | 0.00887 | 0.00847 | 0.00846 | 0.00883 | 0.00882 | 0.00881 |
| 16\* | 0.00882 | 0.00891 | 0.00901 | 0.00921 | 0.00922 | 0.00911 | 0.00894 |
| 17 | 0.00860 | 0.00858 | 0.00861 | 0.00862 | 0.00863 | 0.00869 | 0.00866 |
| 18 | 0.00845 | 0.00854 | 0.00833 | 0.00868 | 0.00852 | 0.00860 | 0.00848 |
| 4 | 1 | 0.0287 | 0.0294 | 0.0296 | 0.0288 | 0.0297 | 0.0291 | 0.0288 |
| 2 | 0.0286 | 0.0291 | 0.0280 | 0.0287 | 0.0291 | 0.0284 | 0.0288 |
| 3 | 0.0281 | 0.0280 | 0.0278 | 0.0273 | 0.0278 | 0.0276 | 0.0276 |
| 4 | 0.0295 | 0.0300 | 0.0297 | 0.0289 | 0.0291 | 0.0296 | 0.0294 |
| 5\* | 0.0250 | 0.0252 | 0.0249 | 0.0248 | 0.0247 | 0.0246 | 0.0244 |
| 6 | 0.0285 | 0.0286 | 0.0298 | 0.0292 | 0.0293 | 0.0285 | 0.0295 |
| 7 | 0.0290 | 0.0293 | 0.0293 | 0.0290 | 0.0291 | 0.0294 | 0.0294 |
| 8 | 0.0295 | 0.0295 | 0.0288 | 0.0290 | 0.0294 | 0.0291 | 0.0292 |
| 9\* | 0.0348 | 0.0350 | 0.0348 | 0.0347 | 0.0349 | 0.0344 | 0.0347 |
| 10 | 0.0289 | 0.0292 | 0.0293 | 0.0289 | 0.0288 | 0.0293 | 0.0290 |
| 11 | 0.0286 | 0.0287 | 0.0277 | 0.0288 | 0.0289 | 0.0284 | 0.0280 |
| 12 | 0.0278 | 0.0278 | 0.0284 | 0.0283 | 0.0286 | 0.0288 | 0.0289 |
| 13 | 0.0306 | 0.0293 | 0.0286 | 0.0295 | 0.0308 | 0.0288 | 0.0296 |
| 14 | 0.0286 | 0.0293 | 0.0297 | 0.0290 | 0.0292 | 0.0291 | 0.0285 |
| 15 | 0.0306 | 0.0300 | 0.0298 | 0.0295 | 0.0301 | 0.0300 | 0.0298 |
| 16 | 0.0311 | 0.0324 | 0.0333 | 0.0321 | 0.0311 | 0.0312 | 0.0324 |
| 17 | 0.0280 | 0.0285 | 0.0291 | 0.0293 | 0.0290 | 0.0287 | 0.0292 |
| 18 | 0.0301 | 0.0306 | 0.0310 | 0.0302 | 0.0302 | 0.0305 | 0.0298 |
| 5 | 1 | 0.0444 | 0.0452 | 0.0453 | 0.0456 | 0.0454 | 0.0434 | 0.0454 |
| 2 | 0.0407 | 0.0390 | 0.0397 | 0.0394 | 0.0388 | 0.0386 | 0.0390 |
| 3 | 0.0405 | 0.0398 | 0.0411 | 0.0408 | 0.0411 | 0.0405 | 0.0382 |
| 4 | 0.0435 | 0.0449 | 0.0457 | 0.0459 | 0.0453 | 0.0442 | 0.0446 |
| 5\* | 0.0371 | 0.0372 | 0.0373 | 0.0377 | 0.0374 | 0.0372 | 0.0371 |
| 6 | 0.0443 | 0.0454 | 0.0453 | 0.0434 | 0.0451 | 0.0459 | 0.0463 |
| 7 | 0.0436 | 0.0456 | 0.0451 | 0.0442 | 0.0441 | 0.0458 | 0.0442 |
| 8 | 0.0451 | 0.0446 | 0.0441 | 0.0444 | 0.0441 | 0.0432 | 0.0449 |
| 9 | 0.0436 | 0.0437 | 0.0454 | 0.0447 | 0.0434 | 0.0446 | 0.0434 |
| 10 | 0.0447 | 0.0458 | 0.0462 | 0.0455 | 0.0453 | 0.0454 | 0.0445 |
| 11 | 0.0435 | 0.0432 | 0.0438 | 0.0433 | 0.0435 | 0.0438 | 0.0436 |
| 12 | 0.0435 | 0.0429 | 0.0440 | 0.0447 | 0.0445 | 0.0445 | 0.0446 |
| 13 | 0.0441 | 0.0457 | 0.0470 | 0.0448 | 0.0460 | 0.0442 | 0.0453 |
| 14 | 0.0441 | 0.0458 | 0.0453 | 0.0459 | 0.0454 | 0.0437 | 0.0454 |
| 15\* | 0.0551 | 0.0573 | 0.0536 | 0.0557 | 0.0521 | 0.0511 | 0.0562 |
| 16 | 0.0434 | 0.0452 | 0.0473 | 0.0468 | 0.0462 | 0.0467 | 0.0461 |
| 17 | 0.0439 | 0.0433 | 0.0451 | 0.0440 | 0.0451 | 0.0439 | 0.0447 |
| 18 | 0.0456 | 0.0445 | 0.0455 | 0.0444 | 0.0443 | 0.0433 | 0.0431 |

表A.5 锑精密度试验原始数据

| 水平 | 实验室 | *w*Sb /% | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 0.00193 | 0.00195 | 0.00202 | 0.00211 | 0.00203 | 0.00212 | 0.00197 |
| 2 | 0.00204 | 0.00219 | 0.00229 | 0.00212 | 0.00223 | 0.00219 | 0.00238 |
| 3 | 0.00195 | 0.00194 | 0.00198 | 0.00197 | 0.00196 | 0.00199 | 0.00200 |
| 4 | 0.00203 | 0.00195 | 0.00190 | 0.00198 | 0.00209 | 0.00203 | 0.00208 |
| 5 | 0.00202 | 0.00225 | 0.00223 | 0.00221 | 0.00228 | 0.00228 | 0.00227 |
| 6 | 0.00195 | 0.00194 | 0.00213 | 0.00203 | 0.00197 | 0.00196 | 0.00205 |
| 7 | 0.00198 | 0.00187 | 0.00199 | 0.00201 | 0.00194 | 0.00193 | 0.00195 |
| 8 | 0.00215 | 0.00202 | 0.00197 | 0.00196 | 0.00194 | 0.00201 | 0.00201 |
| 9 | 0.00190 | 0.00198 | 0.00201 | 0.00207 | 0.00206 | 0.00202 | 0.00197 |
| 10 | 0.00201 | 0.00205 | 0.00209 | 0.00206 | 0.00203 | 0.00205 | 0.00206 |
| 11 | 0.00196 | 0.00188 | 0.00190 | 0.00189 | 0.00199 | 0.00189 | 0.00192 |
| 12\* | 0.00182 | 0.00186 | 0.00202 | 0.00211 | 0.00183 | 0.00199 | 0.00216 |
| 13 | 0.00216 | 0.00208 | 0.00202 | 0.00203 | 0.00196 | 0.00203 | 0.00195 |
| 14 | 0.00193 | 0.00197 | 0.00202 | 0.00213 | 0.00207 | 0.00211 | 0.00196 |
| 15 | 0.00203 | 0.00211 | 0.00210 | 0.00204 | 0.00203 | 0.00193 | 0.00197 |
| 16 | 0.00192 | 0.00187 | 0.00192 | 0.00184 | 0.00176 | 0.00182 | 0.00175 |
| 17 | 0.00190 | 0.00188 | 0.00190 | 0.00196 | 0.00200 | 0.00195 | 0.00192 |
| 18 | 0.00201 | 0.00197 | 0.00199 | 0.00206 | 0.00198 | 0.00204 | 0.00205 |
| 2 | 1 | 0.00549 | 0.00576 | 0.00564 | 0.00556 | 0.00547 | 0.00573 | 0.00559 |
| 2 | 0.00504 | 0.00508 | 0.00494 | 0.00492 | 0.00500 | 0.00501 | 0.00495 |
| 3 | 0.00552 | 0.00550 | 0.00546 | 0.00558 | 0.00553 | 0.00555 | 0.00551 |
| 4 | 0.00569 | 0.00568 | 0.00561 | 0.00563 | 0.00582 | 0.00558 | 0.00552 |
| 6 | 0.00551 | 0.00578 | 0.00569 | 0.00546 | 0.00567 | 0.00577 | 0.00565 |
| 7 | 0.00547 | 0.00551 | 0.00549 | 0.00557 | 0.00561 | 0.00543 | 0.00560 |
| 8 | 0.00559 | 0.00564 | 0.00567 | 0.00548 | 0.00560 | 0.00553 | 0.00561 |
| 9 | 0.00554 | 0.00581 | 0.00574 | 0.00546 | 0.00557 | 0.00570 | 0.00579 |
| 10 | 0.00560 | 0.00570 | 0.00567 | 0.00561 | 0.00559 | 0.00558 | 0.00555 |
| 11 | 0.00467 | 0.00478 | 0.00488 | 0.00496 | 0.00497 | 0.00489 | 0.00495 |
| 12 | 0.00577 | 0.00563 | 0.00573 | 0.00570 | 0.00571 | 0.00568 | 0.00569 |
| 13 | 0.00546 | 0.00526 | 0.00548 | 0.00558 | 0.00548 | 0.00578 | 0.00560 |
| 14 | 0.00549 | 0.00575 | 0.00560 | 0.00556 | 0.00577 | 0.00573 | 0.00569 |
| 15 | 0.00577 | 0.00581 | 0.00568 | 0.00576 | 0.00556 | 0.00576 | 0.00554 |
| 16 | 0.00512 | 0.00511 | 0.00492 | 0.00523 | 0.00524 | 0.00508 | 0.00517 |
| 18 | 0.00547 | 0.00584 | 0.00558 | 0.00578 | 0.00565 | 0.00574 | 0.00553 |
| 3 | 1 | 0.0176 | 0.0174 | 0.0169 | 0.0172 | 0.0176 | 0.0178 | 0.0167 |
| 2 | 0.0168 | 0.0160 | 0.0163 | 0.0165 | 0.0170 | 0.0163 | 0.0164 |
| 3 | 0.0173 | 0.0173 | 0.0175 | 0.0171 | 0.0170 | 0.0168 | 0.0170 |
| 4 | 0.0180 | 0.0176 | 0.0178 | 0.0173 | 0.0173 | 0.0169 | 0.0167 |
| 5\* | 0.0113 | 0.0113 | 0.0118 | 0.0117 | 0.0120 | 0.0119 | 0.0120 |
| 6 | 0.0171 | 0.0174 | 0.0167 | 0.0173 | 0.0176 | 0.0169 | 0.0166 |
| 7 | 0.0180 | 0.0181 | 0.0172 | 0.0179 | 0.0175 | 0.0179 | 0.0170 |
| 8 | 0.0173 | 0.0173 | 0.0174 | 0.0168 | 0.0169 | 0.0174 | 0.0175 |
| 9 | 0.0179 | 0.0177 | 0.0170 | 0.0182 | 0.0174 | 0.0178 | 0.0177 |
| 10 | 0.0176 | 0.0173 | 0.0175 | 0.0172 | 0.0173 | 0.0175 | 0.0170 |
| 11 | 0.0178 | 0.0179 | 0.0180 | 0.0181 | 0.0181 | 0.0182 | 0.0174 |
| 12 | 0.0168 | 0.0170 | 0.0168 | 0.0179 | 0.0181 | 0.0174 | 0.0175 |
| 13 | 0.0182 | 0.0178 | 0.0172 | 0.0170 | 0.0183 | 0.0173 | 0.0175 |
| 14 | 0.0176 | 0.0174 | 0.0179 | 0.0172 | 0.0166 | 0.0168 | 0.0177 |
| 15 | 0.0180 | 0.0180 | 0.0179 | 0.0178 | 0.0177 | 0.0177 | 0.0176 |
| 16\* | 0.0142 | 0.0153 | 0.0154 | 0.0162 | 0.0154 | 0.0143 | 0.0158 |
| 17 | 0.0170 | 0.0171 | 0.0174 | 0.0170 | 0.0169 | 0.0168 | 0.0171 |
| 18 | 0.0182 | 0.0188 | 0.0180 | 0.0186 | 0.0186 | 0.0177 | 0.0179 |
| 4 | 1 | 0.0242 | 0.0246 | 0.0244 | 0.0238 | 0.0235 | 0.0237 | 0.0239 |
| 2\* | 0.0213 | 0.0215 | 0.0217 | 0.0225 | 0.0216 | 0.0219 | 0.0212 |
| 3 | 0.0233 | 0.0234 | 0.0230 | 0.0228 | 0.0232 | 0.0229 | 0.0233 |
| 4 | 0.0247 | 0.0245 | 0.0246 | 0.0243 | 0.0238 | 0.0240 | 0.0236 |
| 5\* | 0.0173 | 0.0178 | 0.0177 | 0.0177 | 0.0177 | 0.0177 | 0.0176 |
| 6 | 0.0245 | 0.0243 | 0.0245 | 0.0236 | 0.0245 | 0.0244 | 0.0244 |
| 7 | 0.0251 | 0.0252 | 0.0249 | 0.0231 | 0.0250 | 0.0241 | 0.0231 |
| 8 | 0.0234 | 0.0236 | 0.0239 | 0.0245 | 0.0241 | 0.0246 | 0.0240 |
| 9 | 0.0248 | 0.0241 | 0.0240 | 0.0236 | 0.0245 | 0.0247 | 0.0243 |
| 10 | 0.0239 | 0.0238 | 0.0240 | 0.0238 | 0.0239 | 0.0241 | 0.0242 |
| 11 | 0.0246 | 0.0247 | 0.0238 | 0.0245 | 0.0246 | 0.0243 | 0.0237 |
| 12 | 0.0240 | 0.0231 | 0.0241 | 0.0243 | 0.0237 | 0.0239 | 0.0242 |
| 13 | 0.0246 | 0.0254 | 0.0265 | 0.0251 | 0.0240 | 0.0246 | 0.0243 |
| 14 | 0.0234 | 0.0247 | 0.0242 | 0.0239 | 0.0235 | 0.0237 | 0.0238 |
| 15 | 0.0252 | 0.0249 | 0.0238 | 0.0241 | 0.0240 | 0.0242 | 0.0245 |
| 16\* | 0.0162 | 0.0151 | 0.0143 | 0.0161 | 0.0162 | 0.0154 | 0.0162 |
| 17 | 0.0240 | 0.0244 | 0.0241 | 0.0245 | 0.0250 | 0.0244 | 0.0247 |
| 18 | 0.0236 | 0.0232 | 0.0237 | 0.0231 | 0.0243 | 0.0236 | 0.0239 |
| 5 | 1 | 0.0511 | 0.0509 | 0.0516 | 0.0514 | 0.0506 | 0.0516 | 0.0521 |
| 2 | 0.0494 | 0.0493 | 0.0495 | 0.0491 | 0.0499 | 0.0492 | 0.0496 |
| 4 | 0.0526 | 0.0509 | 0.0521 | 0.0508 | 0.0521 | 0.0508 | 0.0515 |
| 6 | 0.0505 | 0.0506 | 0.0504 | 0.0515 | 0.0513 | 0.0503 | 0.0509 |
| 7 | 0.0520 | 0.0519 | 0.0518 | 0.0515 | 0.0524 | 0.0523 | 0.0516 |
| 8 | 0.0506 | 0.0515 | 0.0508 | 0.0509 | 0.0511 | 0.0513 | 0.0507 |
| 9 | 0.0502 | 0.0499 | 0.0506 | 0.0511 | 0.0510 | 0.0505 | 0.0512 |
| 10 | 0.0510 | 0.0518 | 0.0513 | 0.0512 | 0.0515 | 0.0516 | 0.0519 |
| 12 | 0.0510 | 0.0508 | 0.0506 | 0.0501 | 0.0501 | 0.0506 | 0.0508 |
| 13 | 0.0495 | 0.0511 | 0.0505 | 0.0512 | 0.0506 | 0.0498 | 0.0508 |
| 14 | 0.0513 | 0.0510 | 0.0517 | 0.0504 | 0.0507 | 0.0517 | 0.0523 |
| 15 | 0.0521 | 0.0522 | 0.0516 | 0.0517 | 0.0523 | 0.0521 | 0.0516 |
| 16\* | 0.0472 | 0.0454 | 0.0441 | 0.0423 | 0.0444 | 0.0448 | 0.0424 |
| 17 | 0.0505 | 0.0511 | 0.0500 | 0.0496 | 0.0515 | 0.0501 | 0.0509 |
| 18 | 0.0511 | 0.0518 | 0.0501 | 0.0505 | 0.0504 | 0.0515 | 0.0520 |

表A.6 砷精密度试验原始数据

| 水平 | 实验室 | *w*As /% | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 0.00201 | 0.00191 | 0.00207 | 0.00192 | 0.00204 | 0.00196 | 0.00211 |
| 2 | 0.00200 | 0.00208 | 0.00214 | 0.00213 | 0.00200 | 0.00211 | 0.00221 |
| 3\* | 0.00210 | 0.00228 | 0.00251 | 0.00257 | 0.00220 | 0.00243 | 0.00233 |
| 4 | 0.00209 | 0.00193 | 0.00201 | 0.00206 | 0.00196 | 0.00205 | 0.00212 |
| 5 | 0.00193 | 0.00193 | 0.00187 | 0.00185 | 0.00184 | 0.00182 | 0.00180 |
| 6 | 0.00191 | 0.00198 | 0.00213 | 0.00201 | 0.00217 | 0.00213 | 0.00207 |
| 7 | 0.00211 | 0.00190 | 0.00196 | 0.00205 | 0.00198 | 0.00191 | 0.00192 |
| 8 | 0.00195 | 0.00203 | 0.00204 | 0.00194 | 0.00209 | 0.00212 | 0.00191 |
| 9 | 0.00205 | 0.00200 | 0.00206 | 0.00190 | 0.00205 | 0.00202 | 0.00208 |
| 10 | 0.00205 | 0.00205 | 0.00203 | 0.00204 | 0.00200 | 0.00199 | 0.00200 |
| 11 | 0.00192 | 0.00193 | 0.00195 | 0.00199 | 0.00194 | 0.00201 | 0.00198 |
| 12 | 0.00217 | 0.00209 | 0.00216 | 0.00195 | 0.00217 | 0.00210 | 0.00217 |
| 13 | 0.00199 | 0.00196 | 0.00201 | 0.00195 | 0.00201 | 0.00203 | 0.00198 |
| 14 | 0.00205 | 0.00197 | 0.00210 | 0.00195 | 0.00209 | 0.00198 | 0.00212 |
| 15 | 0.00199 | 0.00197 | 0.00205 | 0.00195 | 0.00204 | 0.00196 | 0.00210 |
| 16 | 0.00184 | 0.00169 | 0.00175 | 0.00188 | 0.00169 | 0.00174 | 0.00178 |
| 17 | 0.00205 | 0.00201 | 0.00210 | 0.00205 | 0.00199 | 0.00196 | 0.00200 |
| 18 | 0.00209 | 0.00201 | 0.00193 | 0.00208 | 0.00196 | 0.00208 | 0.00192 |
| 2 | 1 | 0.00485 | 0.00493 | 0.00509 | 0.00513 | 0.00517 | 0.00522 | 0.00505 |
| 2 | 0.00565 | 0.00564 | 0.00542 | 0.00578 | 0.00567 | 0.00542 | 0.00553 |
| 3\* | 0.00497 | 0.00511 | 0.00498 | 0.00568 | 0.00547 | 0.00506 | 0.00505 |
| 4 | 0.00522 | 0.00518 | 0.00510 | 0.00509 | 0.00501 | 0.00496 | 0.00501 |
| 5 | 0.00486 | 0.00492 | 0.00503 | 0.00472 | 0.00453 | 0.00455 | 0.00453 |
| 6 | 0.00500 | 0.00527 | 0.00524 | 0.00495 | 0.00513 | 0.00493 | 0.00497 |
| 7\* | 0.00463 | 0.00472 | 0.00510 | 0.00420 | 0.00481 | 0.00463 | 0.00483 |
| 8 | 0.00522 | 0.00493 | 0.00509 | 0.00513 | 0.00498 | 0.00499 | 0.00507 |
| 9 | 0.00514 | 0.00499 | 0.00499 | 0.00504 | 0.00508 | 0.00503 | 0.00499 |
| 10 | 0.00505 | 0.00504 | 0.00510 | 0.00508 | 0.00512 | 0.00506 | 0.00507 |
| 11 | 0.00521 | 0.00528 | 0.00532 | 0.00524 | 0.00529 | 0.00529 | 0.00521 |
| 12 | 0.00500 | 0.00500 | 0.00500 | 0.00524 | 0.00526 | 0.00485 | 0.00528 |
| 13 | 0.00501 | 0.00485 | 0.00492 | 0.00488 | 0.00498 | 0.00505 | 0.00499 |
| 14 | 0.00495 | 0.00493 | 0.00509 | 0.00503 | 0.00501 | 0.00522 | 0.00505 |
| 15 | 0.00472 | 0.00484 | 0.00475 | 0.00470 | 0.00477 | 0.00483 | 0.00475 |
| 16 | 0.00472 | 0.00453 | 0.00462 | 0.00482 | 0.00463 | 0.00453 | 0.00444 |
| 17 | 0.00496 | 0.00490 | 0.00496 | 0.00495 | 0.00501 | 0.00498 | 0.00503 |
| 18 | 0.00498 | 0.00488 | 0.00476 | 0.00502 | 0.00515 | 0.00494 | 0.00505 |
| 3 | 1 | 0.0113 | 0.0111 | 0.0116 | 0.0108 | 0.0114 | 0.0105 | 0.0111 |
| 2 | 0.0108 | 0.0112 | 0.0112 | 0.0108 | 0.0109 | 0.0107 | 0.0110 |
| 3 | 0.0122 | 0.0121 | 0.0116 | 0.0119 | 0.0117 | 0.0121 | 0.0123 |
| 4 | 0.0106 | 0.0109 | 0.0115 | 0.0107 | 0.0108 | 0.0112 | 0.0116 |
| 5 | 0.0105 | 0.0106 | 0.0104 | 0.0104 | 0.0104 | 0.0103 | 0.0102 |
| 6 | 0.0114 | 0.0106 | 0.0108 | 0.0117 | 0.0109 | 0.0113 | 0.0109 |
| 7 | 0.0102 | 0.0112 | 0.0109 | 0.0103 | 0.0105 | 0.0107 | 0.0103 |
| 8 | 0.0112 | 0.0115 | 0.0111 | 0.0113 | 0.0109 | 0.0108 | 0.0107 |
| 9 | 0.0114 | 0.0109 | 0.0108 | 0.0114 | 0.0109 | 0.0114 | 0.0114 |
| 10 | 0.0118 | 0.0112 | 0.0112 | 0.0112 | 0.0114 | 0.0112 | 0.0113 |
| 11 | 0.0113 | 0.0113 | 0.0106 | 0.0112 | 0.0113 | 0.0107 | 0.0106 |
| 12 | 0.0111 | 0.0107 | 0.0103 | 0.0110 | 0.0104 | 0.0105 | 0.0104 |
| 13 | 0.0112 | 0.0112 | 0.0109 | 0.0120 | 0.0118 | 0.0109 | 0.0113 |
| 14 | 0.0113 | 0.0109 | 0.0115 | 0.0107 | 0.0114 | 0.0105 | 0.0110 |
| 15 | 0.0101 | 0.0103 | 0.0105 | 0.0104 | 0.0102 | 0.0109 | 0.0105 |
| 16 | 0.0099 | 0.0095 | 0.0096 | 0.0095 | 0.0098 | 0.0097 | 0.0094 |
| 17 | 0.0101 | 0.0107 | 0.0110 | 0.0102 | 0.0101 | 0.0110 | 0.0115 |
| 18 | 0.0121 | 0.0118 | 0.0107 | 0.0116 | 0.0115 | 0.0120 | 0.0108 |
| 4 | 1 | 0.0195 | 0.0193 | 0.0204 | 0.0206 | 0.0212 | 0.0214 | 0.0197 |
| 2 | 0.0178 | 0.0185 | 0.0208 | 0.0200 | 0.0184 | 0.0186 | 0.0191 |
| 3 | 0.0206 | 0.0205 | 0.0207 | 0.0206 | 0.0210 | 0.0210 | 0.0213 |
| 4 | 0.0215 | 0.0195 | 0.0201 | 0.0206 | 0.0196 | 0.0201 | 0.0209 |
| 5\* | 0.0177 | 0.0173 | 0.0172 | 0.0174 | 0.0172 | 0.0171 | 0.0168 |
| 6 | 0.0199 | 0.0196 | 0.0193 | 0.0213 | 0.0197 | 0.0197 | 0.0202 |
| 7 | 0.0212 | 0.0213 | 0.0225 | 0.0218 | 0.0219 | 0.0209 | 0.0202 |
| 8 | 0.0197 | 0.0196 | 0.0205 | 0.0204 | 0.0206 | 0.0198 | 0.0205 |
| 9 | 0.0205 | 0.0202 | 0.0201 | 0.0204 | 0.0200 | 0.0208 | 0.0199 |
| 10 | 0.0192 | 0.0196 | 0.0190 | 0.0189 | 0.0199 | 0.0198 | 0.0201 |
| 11 | 0.0196 | 0.0197 | 0.0197 | 0.0199 | 0.0197 | 0.0197 | 0.0199 |
| 12 | 0.0187 | 0.0189 | 0.0189 | 0.0190 | 0.0192 | 0.0192 | 0.0189 |
| 13 | 0.0198 | 0.0197 | 0.0198 | 0.0201 | 0.0205 | 0.0199 | 0.0202 |
| 14 | 0.0195 | 0.0194 | 0.0205 | 0.0207 | 0.0214 | 0.0216 | 0.0198 |
| 15 | 0.0196 | 0.0203 | 0.0197 | 0.0201 | 0.0204 | 0.0199 | 0.0201 |
| 16 | 0.0212 | 0.0209 | 0.0206 | 0.0210 | 0.0213 | 0.0208 | 0.0207 |
| 17 | 0.0198 | 0.0199 | 0.0196 | 0.0192 | 0.0201 | 0.0199 | 0.0202 |
| 18 | 0.0198 | 0.0192 | 0.0191 | 0.0196 | 0.0196 | 0.0203 | 0.0199 |
| 5 | 1 | 0.0462 | 0.0439 | 0.0454 | 0.0458 | 0.0461 | 0.0445 | 0.0443 |
| 2 | 0.0453 | 0.0445 | 0.0439 | 0.0447 | 0.0460 | 0.0447 | 0.0444 |
| 3 | 0.0455 | 0.0457 | 0.0455 | 0.0454 | 0.0457 | 0.0456 | 0.0456 |
| 4 | 0.0452 | 0.0449 | 0.0443 | 0.0456 | 0.0450 | 0.0450 | 0.0441 |
| 5\* | 0.0384 | 0.0379 | 0.0385 | 0.0390 | 0.0378 | 0.0386 | 0.0384 |
| 6 | 0.0453 | 0.0464 | 0.0451 | 0.0451 | 0.0449 | 0.0449 | 0.0449 |
| 7 | 0.0463 | 0.0460 | 0.0458 | 0.0457 | 0.0452 | 0.0462 | 0.0460 |
| 8 | 0.0447 | 0.0450 | 0.0449 | 0.0459 | 0.0455 | 0.0448 | 0.0450 |
| 9 | 0.0459 | 0.0458 | 0.0457 | 0.0461 | 0.0458 | 0.0464 | 0.0467 |
| 10 | 0.0448 | 0.0446 | 0.0448 | 0.0441 | 0.0446 | 0.0447 | 0.0448 |
| 11 | 0.0430 | 0.0431 | 0.0434 | 0.0438 | 0.0440 | 0.0437 | 0.0434 |
| 12 | 0.0458 | 0.0457 | 0.0473 | 0.0467 | 0.0469 | 0.0465 | 0.0463 |
| 13 | 0.0456 | 0.0447 | 0.0432 | 0.0457 | 0.0452 | 0.0454 | 0.0449 |
| 14 | 0.0463 | 0.0459 | 0.0464 | 0.0458 | 0.0461 | 0.0435 | 0.0443 |
| 15 | 0.0456 | 0.0445 | 0.0456 | 0.0441 | 0.0441 | 0.0443 | 0.0447 |
| 16\* | 0.0423 | 0.0424 | 0.0392 | 0.0441 | 0.0429 | 0.0408 | 0.0400 |
| 17 | 0.0450 | 0.0482 | 0.0466 | 0.0453 | 0.0456 | 0.0470 | 0.0463 |
| 18 | 0.0444 | 0.0448 | 0.0458 | 0.0449 | 0.0462 | 0.0457 | 0.0468 |

表A.7 铝精密度试验原始数据

| 水平 | 实验室 | *w*Al /% | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 0.00028 | 0.00031 | 0.00029 | 0.00031 | 0.00032 | 0.00029 | 0.00031 |
| 2 | 0.00038 | 0.00037 | 0.00038 | 0.00039 | 0.00037 | 0.00038 | 0.00038 |
| 3 | 0.00033 | 0.00031 | 0.00030 | 0.00031 | 0.00030 | 0.00029 | 0.00027 |
| 4 | 0.00029 | 0.00031 | 0.00032 | 0.00029 | 0.00028 | 0.00031 | 0.00030 |
| 5\* | 0.00055 | 0.00029 | 0.00061 | 0.00045 | 0.00059 | 0.00035 | 0.00059 |
| 6 | 0.00029 | 0.00031 | 0.00030 | 0.00030 | 0.00029 | 0.00030 | 0.00029 |
| 7 | 0.00027 | 0.00031 | 0.00031 | 0.00028 | 0.00028 | 0.00027 | 0.00029 |
| 8 | 0.00028 | 0.00029 | 0.00030 | 0.00032 | 0.00031 | 0.00030 | 0.00028 |
| 9 | 0.00028 | 0.00030 | 0.00029 | 0.00029 | 0.00031 | 0.00032 | 0.00031 |
| 10 | 0.00030 | 0.00031 | 0.00030 | 0.00031 | 0.00029 | 0.00028 | 0.00031 |
| 11 | 0.00032 | 0.00029 | 0.00028 | 0.00031 | 0.00030 | 0.00034 | 0.00030 |
| 12 | 0.00032 | 0.00034 | 0.00028 | 0.00028 | 0.00030 | 0.00031 | 0.00028 |
| 13 | 0.00028 | 0.00029 | 0.00033 | 0.00032 | 0.00034 | 0.00028 | 0.00029 |
| 14 | 0.00029 | 0.00032 | 0.00028 | 0.00033 | 0.00032 | 0.00029 | 0.00031 |
| 15 | 0.00028 | 0.00032 | 0.00029 | 0.00031 | 0.00033 | 0.00031 | 0.00031 |
| 16 | 0.00041 | 0.00038 | 0.00042 | 0.00041 | 0.00035 | 0.00036 | 0.00038 |
| 17 | 0.00030 | 0.00028 | 0.00029 | 0.00030 | 0.00028 | 0.00029 | 0.00029 |
| 18 | 0.00029 | 0.00030 | 0.00032 | 0.00030 | 0.00031 | 0.00031 | 0.00029 |
| 2 | 1 | 0.00100 | 0.00105 | 0.00096 | 0.00093 | 0.00095 | 0.00110 | 0.00106 |
| 2 | 0.00109 | 0.00108 | 0.00109 | 0.00106 | 0.00110 | 0.00112 | 0.00112 |
| 3 | 0.00097 | 0.00102 | 0.00096 | 0.00091 | 0.00095 | 0.00113 | 0.00106 |
| 4 | 0.00097 | 0.00105 | 0.00094 | 0.00110 | 0.00102 | 0.00103 | 0.00098 |
| 5\* | 0.00078 | 0.00083 | 0.00089 | 0.00080 | 0.00076 | 0.00078 | 0.00070 |
| 6 | 0.00092 | 0.00094 | 0.00095 | 0.00103 | 0.00098 | 0.00107 | 0.00099 |
| 7 | 0.00093 | 0.00095 | 0.00096 | 0.00095 | 0.00098 | 0.00101 | 0.00099 |
| 8 | 0.00099 | 0.00101 | 0.00096 | 0.00100 | 0.00106 | 0.00112 | 0.00098 |
| 9 | 0.00100 | 0.00103 | 0.00104 | 0.00102 | 0.00100 | 0.00104 | 0.00096 |
| 10 | 0.00109 | 0.00107 | 0.00106 | 0.00103 | 0.00104 | 0.00105 | 0.00105 |
| 11 | 0.00098 | 0.00101 | 0.00099 | 0.00105 | 0.00094 | 0.00093 | 0.00098 |
| 12 | 0.00102 | 0.00102 | 0.00098 | 0.00107 | 0.00100 | 0.00099 | 0.00098 |
| 13 | 0.00099 | 0.00101 | 0.00100 | 0.00095 | 0.00098 | 0.00109 | 0.00110 |
| 14 | 0.00104 | 0.00103 | 0.00097 | 0.00096 | 0.00097 | 0.00110 | 0.00102 |
| 15 | 0.00096 | 0.00103 | 0.00097 | 0.00096 | 0.00094 | 0.00107 | 0.00106 |
| 16\* | 0.00111 | 0.00122 | 0.00121 | 0.00143 | 0.00132 | 0.00124 | 0.00121 |
| 17 | 0.00102 | 0.00100 | 0.00102 | 0.00099 | 0.00101 | 0.00104 | 0.00098 |
| 18 | 0.00097 | 0.00104 | 0.00095 | 0.00096 | 0.00108 | 0.00102 | 0.00103 |
| 3 | 1 | 0.00504 | 0.00498 | 0.00493 | 0.00511 | 0.00509 | 0.00521 | 0.00512 |
| 2 | 0.00521 | 0.00515 | 0.00484 | 0.00505 | 0.00493 | 0.00513 | 0.00504 |
| 3\* | 0.00576 | 0.00566 | 0.00566 | 0.00561 | 0.00554 | 0.00561 | 0.00565 |
| 4 | 0.00508 | 0.00515 | 0.00539 | 0.00511 | 0.00529 | 0.00510 | 0.00518 |
| 5\* | 0.00304 | 0.00311 | 0.00295 | 0.00297 | 0.00281 | 0.00283 | 0.00329 |
| 6 | 0.00517 | 0.00506 | 0.00503 | 0.00498 | 0.00493 | 0.00515 | 0.00515 |
| 7 | 0.00512 | 0.00524 | 0.00521 | 0.00540 | 0.00524 | 0.00536 | 0.00540 |
| 8 | 0.00502 | 0.00523 | 0.00501 | 0.00511 | 0.00499 | 0.00512 | 0.00499 |
| 9 | 0.00506 | 0.00505 | 0.00495 | 0.00508 | 0.00507 | 0.00498 | 0.00507 |
| 10 | 0.00505 | 0.00497 | 0.00506 | 0.00507 | 0.00499 | 0.00501 | 0.00507 |
| 11 | 0.00489 | 0.00493 | 0.00491 | 0.00499 | 0.00503 | 0.00498 | 0.00510 |
| 12 | 0.00494 | 0.00503 | 0.00503 | 0.00495 | 0.00493 | 0.00514 | 0.00496 |
| 13 | 0.00500 | 0.00483 | 0.00538 | 0.00501 | 0.00498 | 0.00508 | 0.00492 |
| 14 | 0.00502 | 0.00492 | 0.00493 | 0.00511 | 0.00510 | 0.00520 | 0.00516 |
| 15 | 0.00491 | 0.00487 | 0.00492 | 0.00490 | 0.00502 | 0.00500 | 0.00495 |
| 16\* | 0.00564 | 0.00552 | 0.00591 | 0.00594 | 0.00583 | 0.00572 | 0.00621 |
| 17 | 0.00507 | 0.00508 | 0.00494 | 0.00497 | 0.00502 | 0.00495 | 0.00499 |
| 18 | 0.00510 | 0.00507 | 0.00511 | 0.00508 | 0.00502 | 0.00514 | 0.00515 |
| 4 | 1 | 0.0201 | 0.0203 | 0.0197 | 0.0201 | 0.0196 | 0.0199 | 0.0204 |
| 2 | 0.0215 | 0.0209 | 0.0205 | 0.0204 | 0.0206 | 0.0206 | 0.0209 |
| 3 | 0.0185 | 0.0185 | 0.0187 | 0.0184 | 0.0187 | 0.0184 | 0.0190 |
| 4 | 0.0207 | 0.0207 | 0.0199 | 0.0201 | 0.0205 | 0.0198 | 0.0203 |
| 5 | 0.0177 | 0.0176 | 0.0174 | 0.0177 | 0.0175 | 0.0172 | 0.0173 |
| 6 | 0.0197 | 0.0202 | 0.0203 | 0.0203 | 0.0199 | 0.0203 | 0.0192 |
| 7 | 0.0196 | 0.0199 | 0.0197 | 0.0195 | 0.0199 | 0.0192 | 0.0198 |
| 8 | 0.0206 | 0.0206 | 0.0199 | 0.0198 | 0.0207 | 0.0197 | 0.0203 |
| 9 | 0.0199 | 0.0197 | 0.0199 | 0.0195 | 0.0203 | 0.0199 | 0.0202 |
| 10 | 0.0202 | 0.0202 | 0.0200 | 0.0201 | 0.0202 | 0.0204 | 0.0205 |
| 11 | 0.0200 | 0.0197 | 0.0197 | 0.0197 | 0.0199 | 0.0197 | 0.0199 |
| 12 | 0.0203 | 0.0202 | 0.0210 | 0.0210 | 0.0204 | 0.0209 | 0.0206 |
| 13 | 0.0195 | 0.0198 | 0.0191 | 0.0205 | 0.0199 | 0.0210 | 0.0196 |
| 14 | 0.0202 | 0.0204 | 0.0198 | 0.0201 | 0.0197 | 0.0199 | 0.0203 |
| 15 | 0.0204 | 0.0205 | 0.0206 | 0.0197 | 0.0197 | 0.0195 | 0.0199 |
| 16\* | 0.0211 | 0.0254 | 0.0262 | 0.0244 | 0.0241 | 0.0263 | 0.0284 |
| 17 | 0.0205 | 0.0207 | 0.0202 | 0.0198 | 0.0199 | 0.0201 | 0.0206 |
| 18 | 0.0204 | 0.0200 | 0.0203 | 0.0207 | 0.0207 | 0.0198 | 0.0203 |
| 5 | 1 | 0.0455 | 0.0451 | 0.0446 | 0.0448 | 0.0442 | 0.0452 | 0.0457 |
| 2 | 0.0450 | 0.0433 | 0.0459 | 0.0450 | 0.0440 | 0.0459 | 0.0434 |
| 3 | 0.0441 | 0.0443 | 0.0437 | 0.0430 | 0.0436 | 0.0443 | 0.0439 |
| 4 | 0.0459 | 0.0451 | 0.0456 | 0.0453 | 0.0442 | 0.0459 | 0.0446 |
| 5\* | 0.0406 | 0.0402 | 0.0407 | 0.0410 | 0.0401 | 0.0403 | 0.0402 |
| 6 | 0.0451 | 0.0444 | 0.0455 | 0.0477 | 0.0440 | 0.0450 | 0.0446 |
| 7 | 0.0443 | 0.0458 | 0.0446 | 0.0451 | 0.0453 | 0.0449 | 0.0452 |
| 8 | 0.0450 | 0.0456 | 0.0446 | 0.0455 | 0.0449 | 0.0449 | 0.0452 |
| 9 | 0.0443 | 0.0448 | 0.0452 | 0.0445 | 0.0456 | 0.0446 | 0.0449 |
| 10 | 0.0447 | 0.0456 | 0.0452 | 0.0456 | 0.0452 | 0.0453 | 0.0452 |
| 11 | 0.0442 | 0.0450 | 0.0445 | 0.0449 | 0.0450 | 0.0450 | 0.0446 |
| 12 | 0.0452 | 0.0451 | 0.0454 | 0.0460 | 0.0457 | 0.0456 | 0.0458 |
| 13 | 0.0446 | 0.0455 | 0.0442 | 0.0438 | 0.0458 | 0.0444 | 0.0452 |
| 14 | 0.0445 | 0.0451 | 0.0439 | 0.0450 | 0.0442 | 0.0456 | 0.0459 |
| 15 | 0.0452 | 0.0447 | 0.0453 | 0.0445 | 0.0454 | 0.0446 | 0.0447 |
| 16\* | 0.0521 | 0.0532 | 0.0554 | 0.0563 | 0.0548 | 0.0517 | 0.0536 |
| 18 | 0.0449 | 0.0455 | 0.0456 | 0.0450 | 0.0444 | 0.0460 | 0.0454 |

表A.8 锌精密度试验原始数据

| 水平 | 实验室 | *w*Zn /% | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 0.00032 | 0.00032 | 0.00028 | 0.00031 | 0.00030 | 0.00029 | 0.00033 |
| 2\* | 0.00037 | 0.00035 | 0.00038 | 0.00037 | 0.00038 | 0.00038 | 0.00039 |
| 3 | 0.00030 | 0.00029 | 0.00029 | 0.00027 | 0.00030 | 0.00028 | 0.00029 |
| 4 | 0.00032 | 0.00030 | 0.00031 | 0.00029 | 0.00031 | 0.00032 | 0.00033 |
| 5 | 0.00030 | 0.00030 | 0.00030 | 0.00030 | 0.00030 | 0.00032 | 0.00031 |
| 6 | 0.00033 | 0.00031 | 0.00030 | 0.00028 | 0.00032 | 0.00030 | 0.00032 |
| 7 | 0.00033 | 0.00031 | 0.00034 | 0.00031 | 0.00030 | 0.00032 | 0.00032 |
| 8 | 0.00032 | 0.00029 | 0.00031 | 0.00027 | 0.00031 | 0.00029 | 0.00030 |
| 9 | 0.00032 | 0.00032 | 0.00031 | 0.00029 | 0.00033 | 0.00030 | 0.00031 |
| 10 | 0.00030 | 0.00031 | 0.00032 | 0.00031 | 0.00030 | 0.00029 | 0.00029 |
| 11 | 0.00031 | 0.00028 | 0.00032 | 0.00030 | 0.00033 | 0.00031 | 0.00029 |
| 12 | 0.00031 | 0.00030 | 0.00029 | 0.00029 | 0.00029 | 0.00029 | 0.00030 |
| 13 | 0.00033 | 0.00031 | 0.00029 | 0.00034 | 0.00030 | 0.00032 | 0.00031 |
| 14 | 0.00032 | 0.00032 | 0.00028 | 0.00031 | 0.00032 | 0.00029 | 0.00034 |
| 15 | 0.00029 | 0.00031 | 0.00030 | 0.00032 | 0.00031 | 0.00032 | 0.00033 |
| 16\* | 0.00035 | 0.00033 | 0.00041 | 0.00038 | 0.00039 | 0.00040 | 0.00041 |
| 17 | 0.00029 | 0.00030 | 0.00031 | 0.00030 | 0.00028 | 0.00027 | 0.00030 |
| 18 | 0.00029 | 0.00030 | 0.00030 | 0.00032 | 0.00031 | 0.00031 | 0.00029 |
| 2 | 1 | 0.00095 | 0.00097 | 0.00105 | 0.00102 | 0.00091 | 0.00096 | 0.00094 |
| 2 | 0.00114 | 0.00112 | 0.00111 | 0.00111 | 0.00119 | 0.00117 | 0.00117 |
| 3 | 0.00087 | 0.00086 | 0.00085 | 0.00084 | 0.00085 | 0.00084 | 0.00086 |
| 4 | 0.00095 | 0.00098 | 0.00096 | 0.00105 | 0.00106 | 0.00108 | 0.00097 |
| 5 | 0.00104 | 0.00105 | 0.00103 | 0.00102 | 0.00103 | 0.00104 | 0.00103 |
| 6 | 0.00102 | 0.00106 | 0.00099 | 0.00097 | 0.00099 | 0.00098 | 0.00098 |
| 7 | 0.00111 | 0.00112 | 0.00107 | 0.00108 | 0.00105 | 0.00102 | 0.00103 |
| 8 | 0.00094 | 0.00094 | 0.00094 | 0.00095 | 0.00096 | 0.00096 | 0.00097 |
| 9 | 0.00100 | 0.00104 | 0.00102 | 0.00102 | 0.00101 | 0.00101 | 0.00101 |
| 10 | 0.00101 | 0.00104 | 0.00102 | 0.00105 | 0.00099 | 0.00098 | 0.00101 |
| 11 | 0.00099 | 0.00095 | 0.00101 | 0.00103 | 0.00098 | 0.00094 | 0.00099 |
| 12 | 0.00099 | 0.00104 | 0.00101 | 0.00106 | 0.00104 | 0.00100 | 0.00098 |
| 13 | 0.00104 | 0.00100 | 0.00102 | 0.00106 | 0.00095 | 0.00099 | 0.00103 |
| 14 | 0.00094 | 0.00099 | 0.00102 | 0.00105 | 0.00090 | 0.00095 | 0.00096 |
| 15 | 0.00097 | 0.00095 | 0.00106 | 0.00108 | 0.00093 | 0.00097 | 0.00094 |
| 16 | 0.00101 | 0.00102 | 0.00092 | 0.00096 | 0.00102 | 0.00098 | 0.00101 |
| 18 | 0.00100 | 0.00101 | 0.00106 | 0.00103 | 0.00099 | 0.00105 | 0.00102 |
| 3 | 1 | 0.00499 | 0.00507 | 0.00512 | 0.00508 | 0.00504 | 0.00515 | 0.00504 |
| 2\* | 0.00451 | 0.00450 | 0.00456 | 0.00449 | 0.00434 | 0.00440 | 0.00432 |
| 3 | 0.00494 | 0.00493 | 0.00486 | 0.00485 | 0.00482 | 0.00480 | 0.00492 |
| 4 | 0.00508 | 0.00507 | 0.00499 | 0.00486 | 0.00512 | 0.00510 | 0.00505 |
| 5 | 0.00493 | 0.00498 | 0.00495 | 0.00494 | 0.00492 | 0.00493 | 0.00492 |
| 6 | 0.00491 | 0.00502 | 0.00496 | 0.00491 | 0.00512 | 0.00481 | 0.00511 |
| 7 | 0.00517 | 0.00518 | 0.00515 | 0.00502 | 0.00514 | 0.00506 | 0.00509 |
| 8 | 0.00492 | 0.00497 | 0.00502 | 0.00508 | 0.00514 | 0.00512 | 0.00507 |
| 9 | 0.00512 | 0.00508 | 0.00516 | 0.00508 | 0.00499 | 0.00510 | 0.00511 |
| 10 | 0.00497 | 0.00503 | 0.00504 | 0.00506 | 0.00507 | 0.00506 | 0.00504 |
| 11 | 0.00503 | 0.00515 | 0.00505 | 0.00507 | 0.00485 | 0.00499 | 0.00493 |
| 12 | 0.00479 | 0.00503 | 0.00512 | 0.00496 | 0.00496 | 0.00518 | 0.00490 |
| 13 | 0.00513 | 0.00495 | 0.00489 | 0.00520 | 0.00495 | 0.00491 | 0.00497 |
| 14 | 0.00499 | 0.00506 | 0.00512 | 0.00508 | 0.00505 | 0.00512 | 0.00504 |
| 15 | 0.00487 | 0.00490 | 0.00488 | 0.00492 | 0.00490 | 0.00489 | 0.00499 |
| 16\* | 0.00532 | 0.00574 | 0.00533 | 0.00572 | 0.00551 | 0.00574 | 0.00555 |
| 17 | 0.00509 | 0.00502 | 0.00498 | 0.00502 | 0.00505 | 0.00498 | 0.00501 |
| 18 | 0.00489 | 0.00498 | 0.00505 | 0.00496 | 0.00496 | 0.00511 | 0.00508 |
| 4 | 1 | 0.0201 | 0.0202 | 0.0206 | 0.0191 | 0.0197 | 0.0203 | 0.0210 |
| 2\* | 0.0219 | 0.0218 | 0.0211 | 0.0208 | 0.0200 | 0.0226 | 0.0225 |
| 3 | 0.0187 | 0.0187 | 0.0187 | 0.0187 | 0.0189 | 0.0184 | 0.0189 |
| 4 | 0.0207 | 0.0202 | 0.0195 | 0.0199 | 0.0208 | 0.0194 | 0.0208 |
| 5 | 0.0199 | 0.0198 | 0.0196 | 0.0200 | 0.0200 | 0.0198 | 0.0198 |
| 6 | 0.0195 | 0.0201 | 0.0202 | 0.0204 | 0.0200 | 0.0193 | 0.0194 |
| 7 | 0.0198 | 0.0199 | 0.0208 | 0.0205 | 0.0203 | 0.0201 | 0.0200 |
| 8 | 0.0203 | 0.0204 | 0.0205 | 0.0202 | 0.0203 | 0.0204 | 0.0199 |
| 9 | 0.0198 | 0.0200 | 0.0200 | 0.0202 | 0.0208 | 0.0202 | 0.0199 |
| 10 | 0.0195 | 0.0199 | 0.0197 | 0.0198 | 0.0198 | 0.0199 | 0.0200 |
| 11 | 0.0200 | 0.0196 | 0.0197 | 0.0197 | 0.0198 | 0.0197 | 0.0198 |
| 12 | 0.0199 | 0.0202 | 0.0209 | 0.0209 | 0.0207 | 0.0208 | 0.0207 |
| 13 | 0.0204 | 0.0198 | 0.0196 | 0.0199 | 0.0200 | 0.0205 | 0.0198 |
| 14 | 0.0201 | 0.0202 | 0.0207 | 0.0191 | 0.0198 | 0.0202 | 0.0211 |
| 15 | 0.0201 | 0.0197 | 0.0203 | 0.0196 | 0.0204 | 0.0197 | 0.0196 |
| 16\* | 0.0226 | 0.0220 | 0.0250 | 0.0260 | 0.0230 | 0.0240 | 0.0270 |
| 17 | 0.0210 | 0.0213 | 0.0208 | 0.0219 | 0.0205 | 0.0207 | 0.0215 |
| 18 | 0.0200 | 0.0208 | 0.0208 | 0.0202 | 0.0201 | 0.0201 | 0.0207 |
| 5 | 1 | 0.0442 | 0.0447 | 0.0445 | 0.0457 | 0.0448 | 0.0452 | 0.0453 |
| 2 | 0.0441 | 0.0439 | 0.0439 | 0.0440 | 0.0443 | 0.0439 | 0.0442 |
| 3 | 0.0429 | 0.0428 | 0.0436 | 0.0423 | 0.0427 | 0.0429 | 0.0430 |
| 4 | 0.0446 | 0.0452 | 0.0451 | 0.0454 | 0.0447 | 0.0448 | 0.0440 |
| 5 | 0.0449 | 0.0447 | 0.0454 | 0.0458 | 0.0448 | 0.0451 | 0.0451 |
| 6 | 0.0455 | 0.0448 | 0.0458 | 0.0457 | 0.0447 | 0.0448 | 0.0454 |
| 7 | 0.0459 | 0.0458 | 0.0453 | 0.0462 | 0.0451 | 0.0446 | 0.0451 |
| 8 | 0.0451 | 0.0452 | 0.0455 | 0.0447 | 0.0440 | 0.0441 | 0.0450 |
| 9 | 0.0449 | 0.0453 | 0.0452 | 0.0449 | 0.0451 | 0.0454 | 0.0459 |
| 10 | 0.0447 | 0.0440 | 0.0458 | 0.0447 | 0.0446 | 0.0447 | 0.0452 |
| 11 | 0.0435 | 0.0435 | 0.0436 | 0.0438 | 0.0443 | 0.0440 | 0.0440 |
| 12\* | 0.0437 | 0.0436 | 0.0451 | 0.0452 | 0.0448 | 0.0465 | 0.0463 |
| 13 | 0.0453 | 0.0447 | 0.0452 | 0.0453 | 0.0450 | 0.0448 | 0.0450 |
| 14 | 0.0462 | 0.0441 | 0.0446 | 0.0458 | 0.0449 | 0.0452 | 0.0451 |
| 15 | 0.0454 | 0.0451 | 0.0447 | 0.0452 | 0.0454 | 0.0448 | 0.0457 |
| 16\* | 0.0482 | 0.0522 | 0.0533 | 0.0558 | 0.0582 | 0.0574 | 0.0557 |
| 17 | 0.0451 | 0.0455 | 0.0443 | 0.0449 | 0.0438 | 0.0445 | 0.0442 |
| 18 | 0.0450 | 0.0449 | 0.0441 | 0.0455 | 0.0458 | 0.0454 | 0.0458 |

表A.9 镉精密度试验原始数据

| 水平 | 实验室 | *w*Cd /% | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 0.00030 | 0.00031 | 0.00032 | 0.00034 | 0.00029 | 0.00028 | 0.00031 |
| 2 | 0.00028 | 0.00026 | 0.00027 | 0.00028 | 0.00028 | 0.00028 | 0.00027 |
| 3 | 0.00029 | 0.00030 | 0.00033 | 0.00031 | 0.00032 | 0.00032 | 0.00032 |
| 4 | 0.00032 | 0.00029 | 0.00031 | 0.00032 | 0.00031 | 0.00030 | 0.00028 |
| 5 | 0.00032 | 0.00032 | 0.00033 | 0.00032 | 0.00032 | 0.00033 | 0.00033 |
| 6 | 0.00030 | 0.00030 | 0.00030 | 0.00030 | 0.00030 | 0.00030 | 0.00029 |
| 7 | 0.00030 | 0.00031 | 0.00031 | 0.00032 | 0.00032 | 0.00029 | 0.00032 |
| 8 | 0.00030 | 0.00033 | 0.00030 | 0.00035 | 0.00031 | 0.00031 | 0.00030 |
| 9 | 0.00028 | 0.00030 | 0.00030 | 0.00033 | 0.00030 | 0.00030 | 0.00032 |
| 10 | 0.00030 | 0.00028 | 0.00031 | 0.00031 | 0.00030 | 0.00029 | 0.00030 |
| 11 | 0.00031 | 0.00032 | 0.00030 | 0.00032 | 0.00030 | 0.00030 | 0.00030 |
| 12 | 0.00033 | 0.00031 | 0.00027 | 0.00027 | 0.00031 | 0.00031 | 0.00029 |
| 13 | 0.00032 | 0.00031 | 0.00030 | 0.00033 | 0.00028 | 0.00029 | 0.00032 |
| 14 | 0.00032 | 0.00031 | 0.00032 | 0.00035 | 0.00029 | 0.00029 | 0.00031 |
| 15 | 0.00029 | 0.00033 | 0.00034 | 0.00028 | 0.00029 | 0.00028 | 0.00033 |
| 16 | 0.00031 | 0.00035 | 0.00034 | 0.00032 | 0.00031 | 0.00034 | 0.00038 |
| 17 | 0.00032 | 0.00030 | 0.00029 | 0.00032 | 0.00033 | 0.00029 | 0.00029 |
| 18 | 0.00031 | 0.00031 | 0.00030 | 0.00031 | 0.00032 | 0.00031 | 0.00031 |
| 2 | 1 | 0.00099 | 0.00102 | 0.00104 | 0.00096 | 0.00094 | 0.00097 | 0.00102 |
| 2 | 0.00097 | 0.00097 | 0.00098 | 0.00099 | 0.00101 | 0.00102 | 0.00097 |
| 3 | 0.00100 | 0.00086 | 0.00087 | 0.00090 | 0.00089 | 0.00088 | 0.00087 |
| 4 | 0.00108 | 0.00102 | 0.00104 | 0.00106 | 0.00103 | 0.00096 | 0.00098 |
| 5 | 0.00109 | 0.00109 | 0.00108 | 0.00107 | 0.00108 | 0.00108 | 0.00108 |
| 6 | 0.00096 | 0.00097 | 0.00100 | 0.00091 | 0.00100 | 0.00094 | 0.00092 |
| 7 | 0.00102 | 0.00102 | 0.00101 | 0.00101 | 0.00103 | 0.00104 | 0.00103 |
| 8 | 0.00101 | 0.00098 | 0.00101 | 0.00099 | 0.00100 | 0.00103 | 0.00099 |
| 9 | 0.00099 | 0.00104 | 0.00102 | 0.00102 | 0.00102 | 0.00102 | 0.00098 |
| 10 | 0.00100 | 0.00101 | 0.00100 | 0.00101 | 0.00099 | 0.00098 | 0.00100 |
| 11 | 0.00101 | 0.00102 | 0.00102 | 0.00102 | 0.00101 | 0.00102 | 0.00102 |
| 12 | 0.00101 | 0.00105 | 0.00102 | 0.00108 | 0.00103 | 0.00103 | 0.00100 |
| 13 | 0.00105 | 0.00101 | 0.00108 | 0.00095 | 0.00098 | 0.00102 | 0.00101 |
| 14 | 0.00099 | 0.00104 | 0.00105 | 0.00097 | 0.00093 | 0.00099 | 0.00102 |
| 15 | 0.00097 | 0.00105 | 0.00103 | 0.00097 | 0.00095 | 0.00094 | 0.00103 |
| 16 | 0.00101 | 0.00102 | 0.00100 | 0.00097 | 0.00096 | 0.00102 | 0.00103 |
| 17 | 0.00100 | 0.00098 | 0.00095 | 0.00099 | 0.00103 | 0.00101 | 0.00106 |
| 18 | 0.00106 | 0.00104 | 0.00101 | 0.00104 | 0.00105 | 0.00101 | 0.00102 |
| 3 | 1 | 0.00601 | 0.00612 | 0.00618 | 0.00621 | 0.00609 | 0.00614 | 0.00606 |
| 2 | 0.00583 | 0.00576 | 0.00564 | 0.00558 | 0.00545 | 0.00548 | 0.00542 |
| 3 | 0.00589 | 0.00578 | 0.00565 | 0.00580 | 0.00568 | 0.00567 | 0.00574 |
| 4 | 0.00619 | 0.00622 | 0.00608 | 0.00605 | 0.00609 | 0.00620 | 0.00610 |
| 5 | 0.00608 | 0.00617 | 0.00615 | 0.00613 | 0.00612 | 0.00615 | 0.00614 |
| 6 | 0.00622 | 0.00601 | 0.00602 | 0.00621 | 0.00599 | 0.00610 | 0.00623 |
| 7 | 0.00606 | 0.00613 | 0.00613 | 0.00619 | 0.00596 | 0.00600 | 0.00632 |
| 8 | 0.00620 | 0.00605 | 0.00621 | 0.00606 | 0.00609 | 0.00619 | 0.00623 |
| 9 | 0.00612 | 0.00617 | 0.00615 | 0.00607 | 0.00618 | 0.00609 | 0.00610 |
| 10 | 0.00611 | 0.00619 | 0.00613 | 0.00612 | 0.00605 | 0.00607 | 0.00610 |
| 11 | 0.00599 | 0.00606 | 0.00598 | 0.00598 | 0.00605 | 0.00588 | 0.00596 |
| 12 | 0.00595 | 0.00613 | 0.00620 | 0.00605 | 0.00599 | 0.00626 | 0.00601 |
| 13 | 0.00613 | 0.00617 | 0.00628 | 0.00615 | 0.00605 | 0.00609 | 0.00611 |
| 14 | 0.00601 | 0.00602 | 0.00618 | 0.00623 | 0.00609 | 0.00614 | 0.00609 |
| 15 | 0.00621 | 0.00619 | 0.00618 | 0.00617 | 0.00620 | 0.00615 | 0.00617 |
| 16 | 0.00581 | 0.00602 | 0.00611 | 0.00602 | 0.00584 | 0.00605 | 0.00584 |
| 17 | 0.00606 | 0.00601 | 0.00596 | 0.00591 | 0.00622 | 0.00617 | 0.00612 |
| 18 | 0.00606 | 0.00610 | 0.00606 | 0.00602 | 0.00608 | 0.00602 | 0.00604 |
| 4 | 1 | 0.0194 | 0.0196 | 0.0203 | 0.0206 | 0.0201 | 0.0209 | 0.0198 |
| 2\* | 0.0212 | 0.0211 | 0.0204 | 0.0199 | 0.0221 | 0.0223 | 0.0223 |
| 3 | 0.0185 | 0.0186 | 0.0186 | 0.0186 | 0.0185 | 0.0181 | 0.0187 |
| 4 | 0.0205 | 0.0208 | 0.0195 | 0.0199 | 0.0205 | 0.0196 | 0.0200 |
| 5 | 0.0203 | 0.0203 | 0.0201 | 0.0206 | 0.0206 | 0.0204 | 0.0204 |
| 6 | 0.0199 | 0.0198 | 0.0202 | 0.0202 | 0.0202 | 0.0198 | 0.0209 |
| 7 | 0.0191 | 0.0194 | 0.0202 | 0.0198 | 0.0203 | 0.0198 | 0.0196 |
| 8 | 0.0199 | 0.0199 | 0.0201 | 0.0205 | 0.0200 | 0.0206 | 0.0198 |
| 9 | 0.0199 | 0.0199 | 0.0201 | 0.0198 | 0.0207 | 0.0201 | 0.0204 |
| 10 | 0.0202 | 0.0193 | 0.0202 | 0.0192 | 0.0200 | 0.0201 | 0.0199 |
| 11 | 0.0193 | 0.0194 | 0.0191 | 0.0191 | 0.0193 | 0.0194 | 0.0192 |
| 12 | 0.0202 | 0.0204 | 0.0209 | 0.0210 | 0.0206 | 0.0209 | 0.0206 |
| 13 | 0.0201 | 0.0198 | 0.0196 | 0.0197 | 0.0200 | 0.0205 | 0.0203 |
| 14 | 0.0195 | 0.0196 | 0.0208 | 0.0206 | 0.0202 | 0.0209 | 0.0199 |
| 15 | 0.0195 | 0.0196 | 0.0201 | 0.0203 | 0.0201 | 0.0205 | 0.0197 |
| 16 | 0.0214 | 0.0211 | 0.0212 | 0.0214 | 0.0202 | 0.0211 | 0.0213 |
| 17 | 0.0204 | 0.0199 | 0.0197 | 0.0199 | 0.0204 | 0.0201 | 0.0203 |
| 18 | 0.0203 | 0.0198 | 0.0202 | 0.0203 | 0.0199 | 0.0208 | 0.0208 |
| 5 | 1 | 0.0451 | 0.0458 | 0.0450 | 0.0447 | 0.0455 | 0.0449 | 0.0448 |
| 2 | 0.0446 | 0.0435 | 0.0449 | 0.0452 | 0.0455 | 0.0458 | 0.0457 |
| 3 | 0.0420 | 0.0424 | 0.0429 | 0.0424 | 0.0423 | 0.0426 | 0.0429 |
| 4 | 0.0450 | 0.0449 | 0.0448 | 0.0452 | 0.0439 | 0.0448 | 0.0450 |
| 5 | 0.0465 | 0.0464 | 0.0471 | 0.0476 | 0.0466 | 0.0469 | 0.0469 |
| 6 | 0.0452 | 0.0458 | 0.0457 | 0.0450 | 0.0449 | 0.0452 | 0.0452 |
| 7 | 0.0458 | 0.0452 | 0.0449 | 0.0451 | 0.0459 | 0.0456 | 0.0458 |
| 8 | 0.0445 | 0.0442 | 0.0447 | 0.0448 | 0.0453 | 0.0456 | 0.0449 |
| 9 | 0.0447 | 0.0449 | 0.0447 | 0.0447 | 0.0446 | 0.0451 | 0.0456 |
| 10 | 0.0448 | 0.0440 | 0.0449 | 0.0442 | 0.0446 | 0.0447 | 0.0445 |
| 11 | 0.0445 | 0.0452 | 0.0453 | 0.0443 | 0.0448 | 0.0454 | 0.0454 |
| 12 | 0.0458 | 0.0459 | 0.0463 | 0.0455 | 0.0451 | 0.0456 | 0.0463 |
| 13 | 0.0454 | 0.0452 | 0.0448 | 0.0440 | 0.0456 | 0.0452 | 0.0451 |
| 14 | 0.0455 | 0.0437 | 0.0453 | 0.0447 | 0.0452 | 0.0449 | 0.0444 |
| 15 | 0.0455 | 0.0457 | 0.0451 | 0.0447 | 0.0445 | 0.0452 | 0.0454 |
| 16\* | 0.0452 | 0.0463 | 0.0464 | 0.0479 | 0.0468 | 0.0442 | 0.0481 |
| 17 | 0.0440 | 0.0446 | 0.0437 | 0.0439 | 0.0450 | 0.0445 | 0.0455 |
| 18 | 0.0450 | 0.0455 | 0.0454 | 0.0455 | 0.0459 | 0.0447 | 0.0446 |

表A.10 银精密度试验原始数据

| 水平 | 实验室 | *w*Ag /% | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 0.00031 | 0.00031 | 0.00032 | 0.00030 | 0.00029 | 0.00031 | 0.00032 |
| 2 | 0.00030 | 0.00030 | 0.00030 | 0.00030 | 0.00030 | 0.00029 | 0.00029 |
| 3 | 0.00030 | 0.00031 | 0.00031 | 0.00031 | 0.00032 | 0.00031 | 0.00031 |
| 4 | 0.00030 | 0.00031 | 0.00028 | 0.00029 | 0.00031 | 0.00030 | 0.00029 |
| 5\* | 0.00023 | 0.00023 | 0.00023 | 0.00025 | 0.00024 | 0.00022 | 0.00024 |
| 6 | 0.00030 | 0.00031 | 0.00029 | 0.00030 | 0.00029 | 0.00032 | 0.00029 |
| 7 | 0.00031 | 0.00028 | 0.00032 | 0.00029 | 0.00029 | 0.00030 | 0.00031 |
| 8 | 0.00029 | 0.00029 | 0.00031 | 0.00029 | 0.00030 | 0.00032 | 0.00031 |
| 9 | 0.00031 | 0.00031 | 0.00032 | 0.00031 | 0.00029 | 0.00033 | 0.00030 |
| 10 | 0.00031 | 0.00031 | 0.00030 | 0.00031 | 0.00029 | 0.00030 | 0.00029 |
| 11 | 0.00032 | 0.00036 | 0.00033 | 0.00034 | 0.00032 | 0.00029 | 0.00030 |
| 12 | 0.00028 | 0.00031 | 0.00027 | 0.00031 | 0.00029 | 0.00031 | 0.00029 |
| 13 | 0.00030 | 0.00033 | 0.00032 | 0.00033 | 0.00028 | 0.00029 | 0.00031 |
| 14 | 0.00033 | 0.00031 | 0.00031 | 0.00030 | 0.00028 | 0.00031 | 0.00032 |
| 15 | 0.00033 | 0.00033 | 0.00029 | 0.00033 | 0.00028 | 0.00032 | 0.00033 |
| 16\* | 0.00032 | 0.00035 | 0.00038 | 0.00034 | 0.00040 | 0.00036 | 0.00037 |
| 17 | 0.00030 | 0.00029 | 0.00031 | 0.00028 | 0.00028 | 0.00030 | 0.00029 |
| 18 | 0.00029 | 0.00028 | 0.00029 | 0.00031 | 0.00031 | 0.00029 | 0.00030 |
| 2 | 1 | 0.00101 | 0.00108 | 0.00098 | 0.00096 | 0.00102 | 0.00104 | 0.00105 |
| 2 | 0.00102 | 0.00097 | 0.00090 | 0.00102 | 0.00105 | 0.00101 | 0.00102 |
| 3 | 0.00102 | 0.00093 | 0.00092 | 0.00094 | 0.00094 | 0.00094 | 0.00094 |
| 4 | 0.00104 | 0.00102 | 0.00102 | 0.00107 | 0.00098 | 0.00096 | 0.00106 |
| 5\* | 0.00059 | 0.00044 | 0.00066 | 0.00048 | 0.00053 | 0.00046 | 0.00070 |
| 6 | 0.00102 | 0.00099 | 0.00097 | 0.00097 | 0.00108 | 0.00103 | 0.00098 |
| 7 | 0.00105 | 0.00106 | 0.00103 | 0.00107 | 0.00103 | 0.00106 | 0.00110 |
| 8 | 0.00105 | 0.00099 | 0.00103 | 0.00100 | 0.00104 | 0.00099 | 0.00098 |
| 9 | 0.00098 | 0.00103 | 0.00101 | 0.00101 | 0.00099 | 0.00104 | 0.00103 |
| 10 | 0.00105 | 0.00106 | 0.00102 | 0.00103 | 0.00105 | 0.00104 | 0.00103 |
| 11 | 0.00103 | 0.00103 | 0.00104 | 0.00104 | 0.00103 | 0.00104 | 0.00102 |
| 12 | 0.00107 | 0.00112 | 0.00107 | 0.00115 | 0.00111 | 0.00107 | 0.00105 |
| 13 | 0.00102 | 0.00103 | 0.00108 | 0.00095 | 0.00101 | 0.00098 | 0.00104 |
| 14 | 0.00101 | 0.00108 | 0.00099 | 0.00097 | 0.00102 | 0.00102 | 0.00106 |
| 15 | 0.00104 | 0.00107 | 0.00096 | 0.00097 | 0.00103 | 0.00105 | 0.00106 |
| 16\* | 0.00122 | 0.00134 | 0.00141 | 0.00121 | 0.00122 | 0.00133 | 0.00121 |
| 17 | 0.00104 | 0.00101 | 0.00104 | 0.00098 | 0.00097 | 0.00101 | 0.00104 |
| 18 | 0.00098 | 0.00096 | 0.00105 | 0.00106 | 0.00101 | 0.00099 | 0.00104 |
| 3 | 1 | 0.00477 | 0.00487 | 0.00484 | 0.00480 | 0.00492 | 0.00483 | 0.00479 |
| 2 | 0.00440 | 0.00445 | 0.00441 | 0.00450 | 0.00450 | 0.00450 | 0.00455 |
| 3 | 0.00497 | 0.00496 | 0.00496 | 0.00493 | 0.00493 | 0.00492 | 0.00495 |
| 4 | 0.00486 | 0.00481 | 0.00494 | 0.00490 | 0.00478 | 0.00489 | 0.00486 |
| 5 | 0.00512 | 0.00498 | 0.00508 | 0.00510 | 0.00499 | 0.00534 | 0.00493 |
| 6 | 0.00477 | 0.00483 | 0.00496 | 0.00488 | 0.00475 | 0.00485 | 0.00474 |
| 7 | 0.00480 | 0.00481 | 0.00486 | 0.00481 | 0.00479 | 0.00476 | 0.00483 |
| 8 | 0.00489 | 0.00473 | 0.00488 | 0.00479 | 0.00481 | 0.00486 | 0.00477 |
| 9 | 0.00492 | 0.00501 | 0.00495 | 0.00499 | 0.00501 | 0.00498 | 0.00499 |
| 10 | 0.00483 | 0.00490 | 0.00487 | 0.00485 | 0.00486 | 0.00483 | 0.00482 |
| 11 | 0.00494 | 0.00497 | 0.00503 | 0.00503 | 0.00523 | 0.00512 | 0.00500 |
| 12 | 0.00478 | 0.00476 | 0.00477 | 0.00473 | 0.00480 | 0.00476 | 0.00474 |
| 13 | 0.00502 | 0.00512 | 0.00485 | 0.00490 | 0.00475 | 0.00480 | 0.00473 |
| 14 | 0.00479 | 0.00497 | 0.00484 | 0.00481 | 0.00497 | 0.00485 | 0.00478 |
| 15 | 0.00461 | 0.00482 | 0.00481 | 0.00473 | 0.00492 | 0.00503 | 0.00491 |
| 16\* | 0.00481 | 0.00482 | 0.00521 | 0.00524 | 0.00511 | 0.00483 | 0.00494 |
| 17 | 0.00464 | 0.00473 | 0.00468 | 0.00471 | 0.00469 | 0.00465 | 0.00470 |
| 18 | 0.00491 | 0.00483 | 0.00482 | 0.00483 | 0.00472 | 0.00467 | 0.00477 |
| 4 | 1 | 0.0108 | 0.0106 | 0.0107 | 0.0108 | 0.0107 | 0.0108 | 0.0109 |
| 2 | 0.0102 | 0.0102 | 0.0100 | 0.0100 | 0.0103 | 0.0101 | 0.0103 |
| 3 | 0.0123 | 0.0117 | 0.0121 | 0.0122 | 0.0121 | 0.0119 | 0.0121 |
| 4 | 0.0111 | 0.0106 | 0.0109 | 0.0107 | 0.0110 | 0.0108 | 0.0110 |
| 5\* | 0.0038 | 0.0034 | 0.0040 | 0.0039 | 0.0046 | 0.0035 | 0.0046 |
| 6\* | 0.0010 | 0.0010 | 0.0011 | 0.0010 | 0.0011 | 0.0010 | 0.0011 |
| 7 | 0.0107 | 0.0108 | 0.0108 | 0.0107 | 0.0109 | 0.0107 | 0.0106 |
| 8 | 0.0110 | 0.0109 | 0.0106 | 0.0108 | 0.0111 | 0.0107 | 0.0108 |
| 9 | 0.0107 | 0.0104 | 0.0106 | 0.0108 | 0.0108 | 0.0104 | 0.0110 |
| 10 | 0.0108 | 0.0106 | 0.0107 | 0.0105 | 0.0106 | 0.0107 | 0.0105 |
| 11 | 0.0105 | 0.0107 | 0.0103 | 0.0105 | 0.0106 | 0.0103 | 0.0104 |
| 12 | 0.0110 | 0.0112 | 0.0111 | 0.0112 | 0.0104 | 0.0109 | 0.0111 |
| 13\* | 0.0113 | 0.0108 | 0.0104 | 0.0107 | 0.0106 | 0.0116 | 0.0103 |
| 14 | 0.0109 | 0.0106 | 0.0107 | 0.0108 | 0.0106 | 0.0108 | 0.0109 |
| 15 | 0.0099 | 0.0098 | 0.0099 | 0.0099 | 0.0100 | 0.0099 | 0.0102 |
| 16\* | 0.0122 | 0.0124 | 0.0142 | 0.0134 | 0.0123 | 0.0131 | 0.0132 |
| 17\* | 0.0112 | 0.0102 | 0.0105 | 0.0098 | 0.0102 | 0.0104 | 0.0101 |
| 18 | 0.0110 | 0.0106 | 0.0109 | 0.0105 | 0.0105 | 0.0108 | 0.0106 |
| 5 | 1 | 0.0194 | 0.0201 | 0.0198 | 0.0196 | 0.0202 | 0.0197 | 0.0204 |
| 2 | 0.0234 | 0.0228 | 0.0221 | 0.0223 | 0.0223 | 0.0228 | 0.0230 |
| 3 | 0.0227 | 0.0227 | 0.0230 | 0.0227 | 0.0231 | 0.0218 | 0.0231 |
| 4 | 0.0205 | 0.0205 | 0.0204 | 0.0198 | 0.0202 | 0.0203 | 0.0199 |
| 5 | 0.0214 | 0.0213 | 0.0210 | 0.0215 | 0.0217 | 0.0215 | 0.0215 |
| 6 | 0.0192 | 0.0205 | 0.0202 | 0.0195 | 0.0198 | 0.0203 | 0.0193 |
| 7 | 0.0202 | 0.0203 | 0.0200 | 0.0198 | 0.0206 | 0.0204 | 0.0196 |
| 8 | 0.0195 | 0.0196 | 0.0199 | 0.0201 | 0.0198 | 0.0201 | 0.0202 |
| 9 | 0.0193 | 0.0196 | 0.0194 | 0.0198 | 0.0203 | 0.0200 | 0.0202 |
| 10 | 0.0198 | 0.0198 | 0.0199 | 0.0200 | 0.0201 | 0.0201 | 0.0203 |
| 11 | 0.0201 | 0.0196 | 0.0197 | 0.0197 | 0.0198 | 0.0198 | 0.0198 |
| 12 | 0.0192 | 0.0193 | 0.0203 | 0.0206 | 0.0194 | 0.0201 | 0.0194 |
| 13\* | 0.0195 | 0.0193 | 0.0200 | 0.0210 | 0.0216 | 0.0200 | 0.0196 |
| 14 | 0.0196 | 0.0207 | 0.0197 | 0.0196 | 0.0206 | 0.0198 | 0.0204 |
| 15 | 0.0199 | 0.0197 | 0.0203 | 0.0205 | 0.0203 | 0.0200 | 0.0194 |
| 16\* | 0.0202 | 0.0210 | 0.0224 | 0.0232 | 0.0221 | 0.0254 | 0.0243 |
| 17 | 0.0191 | 0.0198 | 0.0195 | 0.0199 | 0.0201 | 0.0205 | 0.0202 |
| 18 | 0.0202 | 0.0204 | 0.0202 | 0.0198 | 0.0205 | 0.0208 | 0.0203 |
| 6 | 1 | 0.0455 | 0.0460 | 0.0453 | 0.0459 | 0.0457 | 0.0445 | 0.0455 |
| 2\* | 0.0475 | 0.0469 | 0.0437 | 0.0480 | 0.0492 | 0.0485 | 0.0484 |
| 3 | 0.0444 | 0.0451 | 0.0461 | 0.0448 | 0.0449 | 0.0458 | 0.0453 |
| 4 | 0.0462 | 0.0456 | 0.0451 | 0.0463 | 0.0450 | 0.0453 | 0.0458 |
| 5\* | 0.0596 | 0.0592 | 0.0602 | 0.0618 | 0.0598 | 0.0610 | 0.0605 |
| 6 | 0.0454 | 0.0444 | 0.0459 | 0.0457 | 0.0452 | 0.0453 | 0.0451 |
| 7 | 0.0458 | 0.0460 | 0.0452 | 0.0458 | 0.0451 | 0.0449 | 0.0456 |
| 8 | 0.0457 | 0.0454 | 0.0452 | 0.0448 | 0.0449 | 0.0451 | 0.0459 |
| 9 | 0.0446 | 0.0448 | 0.0445 | 0.0447 | 0.0449 | 0.0449 | 0.0460 |
| 10 | 0.0450 | 0.0451 | 0.0446 | 0.0449 | 0.0452 | 0.0451 | 0.0454 |
| 11 | 0.0455 | 0.0460 | 0.0453 | 0.0459 | 0.0457 | 0.0445 | 0.0455 |
| 12 | 0.0459 | 0.0464 | 0.0462 | 0.0469 | 0.0454 | 0.0461 | 0.0441 |
| 13 | 0.0449 | 0.0448 | 0.0448 | 0.0452 | 0.0450 | 0.0447 | 0.0453 |
| 14 | 0.0452 | 0.0462 | 0.0455 | 0.0459 | 0.0452 | 0.0441 | 0.0456 |
| 15 | 0.0457 | 0.0451 | 0.0449 | 0.0447 | 0.0457 | 0.0453 | 0.0454 |
| 16\* | 0.0491 | 0.0522 | 0.0563 | 0.0544 | 0.0554 | 0.0522 | 0.0571 |
| 17 | 0.0461 | 0.0464 | 0.0459 | 0.0452 | 0.0460 | 0.0464 | 0.0449 |
| 18 | 0.0451 | 0.0452 | 0.0447 | 0.0445 | 0.0458 | 0.0457 | 0.0451 |

表A.11 镍精密度试验原始数据

| 水平 | 实验室 | *w*Ni /% | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 0.00029 | 0.00027 | 0.00030 | 0.00029 | 0.00028 | 0.00033 | 0.00032 |
| 2 | 0.00035 | 0.00035 | 0.00034 | 0.00033 | 0.00033 | 0.00034 | 0.00034 |
| 3 | 0.00026 | 0.00027 | 0.00026 | 0.00025 | 0.00026 | 0.00030 | 0.00025 |
| 4 | 0.00031 | 0.00029 | 0.00032 | 0.00029 | 0.00030 | 0.00032 | 0.00032 |
| 5 | 0.00029 | 0.00029 | 0.00029 | 0.00028 | 0.00028 | 0.00029 | 0.00029 |
| 6 | 0.00027 | 0.00031 | 0.00033 | 0.00034 | 0.00030 | 0.00032 | 0.00028 |
| 7 | 0.00028 | 0.00029 | 0.00028 | 0.00030 | 0.00028 | 0.00026 | 0.00027 |
| 8 | 0.00029 | 0.00028 | 0.00031 | 0.00026 | 0.00030 | 0.00032 | 0.00030 |
| 9 | 0.00029 | 0.00029 | 0.00028 | 0.00030 | 0.00031 | 0.00033 | 0.00030 |
| 10 | 0.00030 | 0.00031 | 0.00031 | 0.00031 | 0.00031 | 0.00030 | 0.00031 |
| 11 | 0.00030 | 0.00030 | 0.00031 | 0.00030 | 0.00032 | 0.00031 | 0.00031 |
| 12 | 0.00033 | 0.00030 | 0.00028 | 0.00027 | 0.00033 | 0.00031 | 0.00032 |
| 13 | 0.00027 | 0.00029 | 0.00028 | 0.00028 | 0.00030 | 0.00029 | 0.00029 |
| 14 | 0.00028 | 0.00027 | 0.00031 | 0.00029 | 0.00029 | 0.00033 | 0.00032 |
| 15 | 0.00027 | 0.00029 | 0.00031 | 0.00030 | 0.00029 | 0.00033 | 0.00031 |
| 16\* | 0.00041 | 0.00037 | 0.00036 | 0.00041 | 0.00035 | 0.00034 | 0.00041 |
| 18 | 0.00032 | 0.00028 | 0.00028 | 0.00030 | 0.00031 | 0.00032 | 0.00029 |
| 2 | 1 | 0.00105 | 0.00104 | 0.00095 | 0.00096 | 0.00094 | 0.00096 | 0.00095 |
| 2 | 0.00105 | 0.00103 | 0.00091 | 0.00109 | 0.00109 | 0.00108 | 0.00108 |
| 3 | 0.00091 | 0.00088 | 0.00082 | 0.00085 | 0.00092 | 0.00082 | 0.00087 |
| 4 | 0.00103 | 0.00104 | 0.00099 | 0.00106 | 0.00101 | 0.00094 | 0.00096 |
| 5 | 0.00093 | 0.00094 | 0.00092 | 0.00092 | 0.00092 | 0.00097 | 0.00092 |
| 6 | 0.00097 | 0.00098 | 0.00099 | 0.00092 | 0.00104 | 0.00092 | 0.00098 |
| 7 | 0.00098 | 0.00098 | 0.00096 | 0.00096 | 0.00099 | 0.00101 | 0.00102 |
| 8 | 0.00100 | 0.00105 | 0.00103 | 0.00094 | 0.00095 | 0.00095 | 0.00098 |
| 9 | 0.00101 | 0.00095 | 0.00103 | 0.00102 | 0.00102 | 0.00102 | 0.00099 |
| 10 | 0.00101 | 0.00101 | 0.00102 | 0.00111 | 0.00102 | 0.00107 | 0.00102 |
| 11 | 0.00101 | 0.00100 | 0.00102 | 0.00101 | 0.00101 | 0.00099 | 0.00100 |
| 12 | 0.00109 | 0.00110 | 0.00113 | 0.00107 | 0.00107 | 0.00106 | 0.00105 |
| 13 | 0.00096 | 0.00100 | 0.00096 | 0.00104 | 0.00101 | 0.00098 | 0.00096 |
| 14 | 0.00104 | 0.00104 | 0.00097 | 0.00096 | 0.00098 | 0.00095 | 0.00095 |
| 15 | 0.00103 | 0.00103 | 0.00096 | 0.00095 | 0.00093 | 0.00102 | 0.00104 |
| 16 | 0.00101 | 0.00102 | 0.00096 | 0.00103 | 0.00102 | 0.00104 | 0.00101 |
| 17 | 0.00101 | 0.00099 | 0.00102 | 0.00100 | 0.00098 | 0.00098 | 0.00101 |
| 18 | 0.00099 | 0.00103 | 0.00105 | 0.00106 | 0.00098 | 0.00100 | 0.00105 |
| 3 | 1 | 0.00246 | 0.00233 | 0.00232 | 0.00232 | 0.00229 | 0.00228 | 0.00222 |
| 2 | 0.00246 | 0.00245 | 0.00250 | 0.00244 | 0.00248 | 0.00244 | 0.00244 |
| 3 | 0.00234 | 0.00232 | 0.00242 | 0.00234 | 0.00231 | 0.00238 | 0.00232 |
| 4 | 0.00235 | 0.00240 | 0.00226 | 0.00235 | 0.00233 | 0.00225 | 0.00234 |
| 5\* | 0.00186 | 0.00179 | 0.00183 | 0.00177 | 0.00176 | 0.00175 | 0.00174 |
| 6 | 0.00237 | 0.00230 | 0.00233 | 0.00228 | 0.00231 | 0.00220 | 0.00247 |
| 7 | 0.00231 | 0.00227 | 0.00228 | 0.00236 | 0.00239 | 0.00216 | 0.00208 |
| 8 | 0.00237 | 0.00246 | 0.00247 | 0.00231 | 0.00228 | 0.00225 | 0.00223 |
| 9 | 0.00236 | 0.00232 | 0.00238 | 0.00238 | 0.00232 | 0.00228 | 0.00238 |
| 10 | 0.00239 | 0.00230 | 0.00235 | 0.00235 | 0.00234 | 0.00238 | 0.00244 |
| 11 | 0.00231 | 0.00233 | 0.00233 | 0.00235 | 0.00234 | 0.00232 | 0.00234 |
| 12 | 0.00227 | 0.00226 | 0.00225 | 0.00240 | 0.00243 | 0.00235 | 0.00236 |
| 13 | 0.00247 | 0.00223 | 0.00229 | 0.00228 | 0.00229 | 0.00230 | 0.00224 |
| 14 | 0.00236 | 0.00243 | 0.00232 | 0.00239 | 0.00230 | 0.00228 | 0.00224 |
| 15 | 0.00238 | 0.00216 | 0.00219 | 0.00222 | 0.00209 | 0.00212 | 0.00213 |
| 16\* | 0.00252 | 0.00264 | 0.00243 | 0.00262 | 0.00273 | 0.00262 | 0.00282 |
| 18 | 0.00238 | 0.00228 | 0.00230 | 0.00233 | 0.00229 | 0.00234 | 0.00235 |
| 4 | 1 | 0.00785 | 0.00790 | 0.00780 | 0.00771 | 0.00783 | 0.00768 | 0.00766 |
| 2 | 0.00767 | 0.00750 | 0.00755 | 0.00748 | 0.00754 | 0.00732 | 0.00732 |
| 3 | 0.00712 | 0.00711 | 0.00699 | 0.00684 | 0.00703 | 0.00696 | 0.00701 |
| 4 | 0.00785 | 0.00782 | 0.00791 | 0.00772 | 0.00778 | 0.00780 | 0.00769 |
| 5 | 0.00748 | 0.00760 | 0.00758 | 0.00756 | 0.00754 | 0.00760 | 0.00765 |
| 6 | 0.00781 | 0.00778 | 0.00778 | 0.00783 | 0.00780 | 0.00752 | 0.00785 |
| 7 | 0.00791 | 0.00782 | 0.00762 | 0.00781 | 0.00769 | 0.00765 | 0.00780 |
| 8 | 0.00782 | 0.00779 | 0.00776 | 0.00783 | 0.00780 | 0.00774 | 0.00770 |
| 9 | 0.00788 | 0.00795 | 0.00796 | 0.00788 | 0.00794 | 0.00784 | 0.00786 |
| 10 | 0.00772 | 0.00779 | 0.00784 | 0.00749 | 0.00786 | 0.00786 | 0.00773 |
| 11 | 0.00765 | 0.00775 | 0.00768 | 0.00747 | 0.00754 | 0.00761 | 0.00776 |
| 12 | 0.00767 | 0.00766 | 0.00771 | 0.00767 | 0.00772 | 0.00783 | 0.00768 |
| 13 | 0.00804 | 0.00761 | 0.00775 | 0.00769 | 0.00786 | 0.00778 | 0.00767 |
| 14 | 0.00782 | 0.00796 | 0.00780 | 0.00775 | 0.00784 | 0.00766 | 0.00769 |
| 15 | 0.00719 | 0.00721 | 0.00699 | 0.00712 | 0.00695 | 0.00713 | 0.00722 |
| 16 | 0.00812 | 0.00793 | 0.00824 | 0.00815 | 0.00794 | 0.00781 | 0.00792 |
| 17 | 0.00792 | 0.00785 | 0.00788 | 0.00780 | 0.00791 | 0.00784 | 0.00780 |
| 18 | 0.00765 | 0.00775 | 0.00766 | 0.00769 | 0.00771 | 0.00772 | 0.00768 |
| 5 | 1 | 0.0211 | 0.0203 | 0.0209 | 0.0204 | 0.0205 | 0.0207 | 0.0204 |
| 2\* | 0.0220 | 0.0195 | 0.0199 | 0.0193 | 0.0200 | 0.0193 | 0.0193 |
| 3 | 0.0199 | 0.0196 | 0.0194 | 0.0193 | 0.0197 | 0.0196 | 0.0195 |
| 4 | 0.0207 | 0.0202 | 0.0200 | 0.0206 | 0.0205 | 0.0204 | 0.0209 |
| 5\* | 0.0183 | 0.0182 | 0.0181 | 0.0180 | 0.0176 | 0.0176 | 0.0175 |
| 6\* | 0.0200 | 0.0202 | 0.0203 | 0.0201 | 0.0220 | 0.0210 | 0.0210 |
| 7 | 0.0204 | 0.0205 | 0.0209 | 0.0203 | 0.0205 | 0.0210 | 0.0209 |
| 8 | 0.0212 | 0.0209 | 0.0203 | 0.0205 | 0.0207 | 0.0206 | 0.0204 |
| 9 | 0.0206 | 0.0208 | 0.0208 | 0.0204 | 0.0205 | 0.0203 | 0.0206 |
| 10 | 0.0211 | 0.0210 | 0.0216 | 0.0213 | 0.0215 | 0.0212 | 0.0215 |
| 11 | 0.0208 | 0.0207 | 0.0207 | 0.0205 | 0.0208 | 0.0205 | 0.0206 |
| 12 | 0.0201 | 0.0201 | 0.0196 | 0.0198 | 0.0199 | 0.0197 | 0.0195 |
| 13 | 0.0213 | 0.0206 | 0.0206 | 0.0210 | 0.0209 | 0.0211 | 0.0204 |
| 14 | 0.0208 | 0.0213 | 0.0210 | 0.0205 | 0.0208 | 0.0209 | 0.0205 |
| 15 | 0.0217 | 0.0213 | 0.0215 | 0.0219 | 0.0224 | 0.0224 | 0.0220 |
| 16\* | 0.0228 | 0.0229 | 0.0221 | 0.0224 | 0.0219 | 0.0214 | 0.0213 |
| 18 | 0.0208 | 0.0211 | 0.0202 | 0.0209 | 0.0210 | 0.0203 | 0.0210 |
| 6 | 1 | 0.0428 | 0.0417 | 0.0418 | 0.0415 | 0.0423 | 0.0425 | 0.0415 |
| 2\* | 0.0343 | 0.0345 | 0.0348 | 0.0347 | 0.0345 | 0.0352 | 0.0349 |
| 3 | 0.0399 | 0.0403 | 0.0398 | 0.0400 | 0.0396 | 0.0395 | 0.0395 |
| 4 | 0.0416 | 0.0413 | 0.0417 | 0.0415 | 0.0414 | 0.0425 | 0.0421 |
| 5 | 0.0358 | 0.0360 | 0.0359 | 0.0360 | 0.0361 | 0.0360 | 0.0353 |
| 6 | 0.0428 | 0.0419 | 0.0423 | 0.0414 | 0.0417 | 0.0428 | 0.0420 |
| 7 | 0.0419 | 0.0420 | 0.0414 | 0.0415 | 0.0418 | 0.0416 | 0.0415 |
| 8 | 0.0428 | 0.0424 | 0.0423 | 0.0429 | 0.0419 | 0.0420 | 0.0419 |
| 9 | 0.0422 | 0.0424 | 0.0422 | 0.0423 | 0.0417 | 0.0424 | 0.0422 |
| 10 | 0.0415 | 0.0421 | 0.0419 | 0.0424 | 0.0413 | 0.0424 | 0.0419 |
| 11 | 0.0418 | 0.0419 | 0.0417 | 0.0425 | 0.0418 | 0.0423 | 0.0413 |
| 12 | 0.0435 | 0.0436 | 0.0423 | 0.0428 | 0.0427 | 0.0422 | 0.0424 |
| 13 | 0.0447 | 0.0432 | 0.0419 | 0.0426 | 0.0427 | 0.0420 | 0.0422 |
| 14 | 0.0429 | 0.0427 | 0.0418 | 0.0416 | 0.0423 | 0.0428 | 0.0419 |
| 15\* | 0.0441 | 0.0442 | 0.0454 | 0.0472 | 0.0457 | 0.0447 | 0.0463 |
| 16 | 0.0408 | 0.0405 | 0.0412 | 0.0410 | 0.0410 | 0.0424 | 0.0411 |
| 17 | 0.0415 | 0.0412 | 0.0409 | 0.0418 | 0.0419 | 0.0412 | 0.0424 |
| 18 | 0.0425 | 0.0428 | 0.0428 | 0.0432 | 0.0425 | 0.0416 | 0.0428 |

表A.12 钴精密度试验原始数据

| 水平 | 实验室 | *w*Co /% | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1 | 0.00030 | 0.00031 | 0.00028 | 0.00032 | 0.00035 | 0.00029 | 0.00032 |
| 2 | 0.00031 | 0.00030 | 0.00031 | 0.00030 | 0.00031 | 0.00031 | 0.00030 |
| 3\* | 0.00031 | 0.00026 | 0.00027 | 0.00028 | 0.00026 | 0.00027 | 0.00026 |
| 4 | 0.00030 | 0.00031 | 0.00029 | 0.00028 | 0.00027 | 0.00031 | 0.00032 |
| 5 | 0.00030 | 0.00030 | 0.00030 | 0.00029 | 0.00030 | 0.00029 | 0.00029 |
| 6 | 0.00030 | 0.00031 | 0.00030 | 0.00030 | 0.00029 | 0.00031 | 0.00031 |
| 7 | 0.00029 | 0.00030 | 0.00029 | 0.00030 | 0.00032 | 0.00028 | 0.00029 |
| 8 | 0.00031 | 0.00031 | 0.00030 | 0.00032 | 0.00031 | 0.00033 | 0.00030 |
| 9 | 0.00028 | 0.00031 | 0.00032 | 0.00033 | 0.00029 | 0.00031 | 0.00033 |
| 10 | 0.00030 | 0.00031 | 0.00031 | 0.00031 | 0.00030 | 0.00030 | 0.00031 |
| 11 | 0.00031 | 0.00032 | 0.00030 | 0.00033 | 0.00030 | 0.00031 | 0.00032 |
| 12 | 0.00031 | 0.00033 | 0.00029 | 0.00031 | 0.00033 | 0.00035 | 0.00030 |
| 13 | 0.00030 | 0.00033 | 0.00027 | 0.00029 | 0.00034 | 0.00028 | 0.00030 |
| 14 | 0.00032 | 0.00031 | 0.00029 | 0.00032 | 0.00034 | 0.00028 | 0.00032 |
| 15 | 0.00032 | 0.00029 | 0.00029 | 0.00031 | 0.00034 | 0.00029 | 0.00031 |
| 16\* | 0.00032 | 0.00033 | 0.00032 | 0.00033 | 0.00038 | 0.00041 | 0.00039 |
| 17 | 0.00031 | 0.00030 | 0.00031 | 0.00028 | 0.00029 | 0.00031 | 0.00030 |
| 18 | 0.00028 | 0.00031 | 0.00030 | 0.00031 | 0.00029 | 0.00030 | 0.00031 |
| 2 | 1 | 0.00101 | 0.00106 | 0.00104 | 0.00099 | 0.00097 | 0.00102 | 0.00096 |
| 2 | 0.00099 | 0.00099 | 0.00093 | 0.00105 | 0.00103 | 0.00103 | 0.00100 |
| 3 | 0.00093 | 0.00093 | 0.00085 | 0.00085 | 0.00085 | 0.00086 | 0.00085 |
| 4 | 0.00101 | 0.00098 | 0.00096 | 0.00099 | 0.00107 | 0.00106 | 0.00098 |
| 5 | 0.00097 | 0.00099 | 0.00096 | 0.00096 | 0.00097 | 0.00096 | 0.00097 |
| 6 | 0.00107 | 0.00105 | 0.00095 | 0.00097 | 0.00101 | 0.00099 | 0.00102 |
| 7 | 0.00099 | 0.00099 | 0.00100 | 0.00101 | 0.00099 | 0.00102 | 0.00101 |
| 8 | 0.00103 | 0.00102 | 0.00101 | 0.00104 | 0.00102 | 0.00104 | 0.00101 |
| 9 | 0.00100 | 0.00102 | 0.00105 | 0.00103 | 0.00106 | 0.00102 | 0.00098 |
| 10 | 0.00100 | 0.00101 | 0.00104 | 0.00104 | 0.00100 | 0.00101 | 0.00101 |
| 11 | 0.00104 | 0.00101 | 0.00103 | 0.00104 | 0.00104 | 0.00103 | 0.00105 |
| 12 | 0.00105 | 0.00109 | 0.00106 | 0.00112 | 0.00107 | 0.00107 | 0.00107 |
| 13 | 0.00100 | 0.00102 | 0.00103 | 0.00098 | 0.00097 | 0.00106 | 0.00101 |
| 14 | 0.00103 | 0.00105 | 0.00104 | 0.00100 | 0.00097 | 0.00101 | 0.00097 |
| 15 | 0.00104 | 0.00103 | 0.00104 | 0.00099 | 0.00097 | 0.00102 | 0.00098 |
| 16 | 0.00121 | 0.00118 | 0.00114 | 0.00122 | 0.00121 | 0.00118 | 0.00117 |
| 17 | 0.00105 | 0.00098 | 0.00101 | 0.00102 | 0.00101 | 0.00103 | 0.00099 |
| 18 | 0.00096 | 0.00096 | 0.00098 | 0.00103 | 0.00101 | 0.00098 | 0.00094 |
| 3 | 1 | 0.00213 | 0.00206 | 0.00215 | 0.00220 | 0.00217 | 0.00212 | 0.00207 |
| 2 | 0.00209 | 0.00213 | 0.00211 | 0.00209 | 0.00211 | 0.00211 | 0.00208 |
| 3 | 0.00211 | 0.00209 | 0.00206 | 0.00209 | 0.00207 | 0.00207 | 0.00209 |
| 4 | 0.00221 | 0.00214 | 0.00210 | 0.00219 | 0.00217 | 0.00208 | 0.00210 |
| 5 | 0.00205 | 0.00202 | 0.00206 | 0.00203 | 0.00203 | 0.00204 | 0.00201 |
| 6 | 0.00194 | 0.00211 | 0.00207 | 0.00208 | 0.00195 | 0.00219 | 0.00219 |
| 7 | 0.00205 | 0.00205 | 0.00204 | 0.00203 | 0.00213 | 0.00198 | 0.00219 |
| 8 | 0.00214 | 0.00210 | 0.00211 | 0.00223 | 0.00224 | 0.00212 | 0.00212 |
| 9 | 0.00214 | 0.00211 | 0.00215 | 0.00216 | 0.00215 | 0.00213 | 0.00213 |
| 10 | 0.00209 | 0.00212 | 0.00217 | 0.00211 | 0.00219 | 0.00210 | 0.00208 |
| 11 | 0.00213 | 0.00214 | 0.00212 | 0.00215 | 0.00215 | 0.00215 | 0.00217 |
| 12 | 0.00205 | 0.00206 | 0.00211 | 0.00216 | 0.00210 | 0.00201 | 0.00210 |
| 13 | 0.00228 | 0.00224 | 0.00212 | 0.00217 | 0.00221 | 0.00217 | 0.00217 |
| 14 | 0.00223 | 0.00216 | 0.00215 | 0.00224 | 0.00217 | 0.00216 | 0.00209 |
| 15 | 0.00203 | 0.00207 | 0.00196 | 0.00193 | 0.00198 | 0.00197 | 0.00197 |
| 16 | 0.00221 | 0.00222 | 0.00211 | 0.00212 | 0.00232 | 0.00221 | 0.00223 |
| 17 | 0.00199 | 0.00205 | 0.00222 | 0.00200 | 0.00198 | 0.00204 | 0.00209 |
| 18 | 0.00202 | 0.00203 | 0.00198 | 0.00211 | 0.00208 | 0.00210 | 0.00214 |
| 4 | 1 | 0.00776 | 0.00768 | 0.00749 | 0.00762 | 0.00754 | 0.00771 | 0.00759 |
| 2 | 0.00747 | 0.00745 | 0.00724 | 0.00738 | 0.00731 | 0.00720 | 0.00714 |
| 3 | 0.00732 | 0.00732 | 0.00719 | 0.00734 | 0.00720 | 0.00735 | 0.00728 |
| 4 | 0.00756 | 0.00759 | 0.00738 | 0.00751 | 0.00766 | 0.00746 | 0.00748 |
| 5 | 0.00743 | 0.00750 | 0.00741 | 0.00738 | 0.00735 | 0.00736 | 0.00729 |
| 6 | 0.00757 | 0.00756 | 0.00759 | 0.00765 | 0.00749 | 0.00757 | 0.00753 |
| 7 | 0.00742 | 0.00736 | 0.00737 | 0.00749 | 0.00756 | 0.00758 | 0.00769 |
| 8 | 0.00770 | 0.00764 | 0.00768 | 0.00759 | 0.00773 | 0.00767 | 0.00771 |
| 9 | 0.00774 | 0.00776 | 0.00787 | 0.00775 | 0.00775 | 0.00765 | 0.00760 |
| 10 | 0.00762 | 0.00769 | 0.00771 | 0.00763 | 0.00762 | 0.00769 | 0.00769 |
| 11 | 0.00750 | 0.00770 | 0.00741 | 0.00762 | 0.00771 | 0.00755 | 0.00748 |
| 12 | 0.00752 | 0.00753 | 0.00749 | 0.00757 | 0.00761 | 0.00767 | 0.00757 |
| 13 | 0.00766 | 0.00745 | 0.00759 | 0.00788 | 0.00768 | 0.00760 | 0.00772 |
| 14 | 0.00779 | 0.00768 | 0.00750 | 0.00763 | 0.00754 | 0.00772 | 0.00761 |
| 15 | 0.00725 | 0.00725 | 0.00713 | 0.00728 | 0.00725 | 0.00724 | 0.00727 |
| 16 | 0.00781 | 0.00812 | 0.00783 | 0.00814 | 0.00791 | 0.00812 | 0.00814 |
| 17 | 0.00759 | 0.00762 | 0.00755 | 0.00767 | 0.00762 | 0.00769 | 0.00760 |
| 18 | 0.00748 | 0.00753 | 0.00751 | 0.00760 | 0.00749 | 0.00755 | 0.00758 |
| 5 | 1 | 0.0211 | 0.0202 | 0.0208 | 0.0199 | 0.0198 | 0.0204 | 0.0195 |
| 2 | 0.0231 | 0.0220 | 0.0197 | 0.0210 | 0.0213 | 0.0220 | 0.0216 |
| 3 | 0.0184 | 0.0186 | 0.0188 | 0.0189 | 0.0186 | 0.0180 | 0.0186 |
| 4 | 0.0209 | 0.0207 | 0.0197 | 0.0203 | 0.0209 | 0.0196 | 0.0202 |
| 5 | 0.0193 | 0.0191 | 0.0190 | 0.0193 | 0.0192 | 0.0189 | 0.0189 |
| 6 | 0.0200 | 0.0200 | 0.0190 | 0.0191 | 0.0212 | 0.0199 | 0.0202 |
| 7 | 0.0193 | 0.0198 | 0.0195 | 0.0201 | 0.0203 | 0.0205 | 0.0199 |
| 8 | 0.0209 | 0.0202 | 0.0210 | 0.0206 | 0.0194 | 0.0199 | 0.0203 |
| 9 | 0.0198 | 0.0196 | 0.0201 | 0.0198 | 0.0205 | 0.0202 | 0.0205 |
| 10 | 0.0210 | 0.0197 | 0.0201 | 0.0193 | 0.0202 | 0.0196 | 0.0201 |
| 11 | 0.0199 | 0.0194 | 0.0197 | 0.0196 | 0.0195 | 0.0194 | 0.0197 |
| 12 | 0.0207 | 0.0207 | 0.0213 | 0.0214 | 0.0209 | 0.0213 | 0.0210 |
| 13 | 0.0198 | 0.0197 | 0.0196 | 0.0206 | 0.0199 | 0.0197 | 0.0207 |
| 14 | 0.0211 | 0.0202 | 0.0208 | 0.0199 | 0.0198 | 0.0204 | 0.0195 |
| 15 | 0.0206 | 0.0207 | 0.0205 | 0.0199 | 0.0197 | 0.0203 | 0.0204 |
| 16 | 0.0208 | 0.0205 | 0.0211 | 0.0212 | 0.0230 | 0.0223 | 0.0210 |
| 17 | 0.0222 | 0.0214 | 0.0201 | 0.0204 | 0.0205 | 0.0211 | 0.0212 |
| 18 | 0.0201 | 0.0205 | 0.0198 | 0.0206 | 0.0202 | 0.0208 | 0.0194 |
| 6 | 1 | 0.0455 | 0.0449 | 0.0446 | 0.0457 | 0.0451 | 0.0456 | 0.0463 |
| 2 | 0.0430 | 0.0435 | 0.0427 | 0.0437 | 0.0434 | 0.0432 | 0.0438 |
| 3 | 0.0425 | 0.0425 | 0.0435 | 0.0425 | 0.0426 | 0.0430 | 0.0428 |
| 4 | 0.0451 | 0.0465 | 0.0444 | 0.0450 | 0.0452 | 0.0449 | 0.0450 |
| 5 | 0.0428 | 0.0424 | 0.0430 | 0.0435 | 0.0424 | 0.0427 | 0.0428 |
| 6 | 0.0453 | 0.0454 | 0.0460 | 0.0454 | 0.0444 | 0.0456 | 0.0459 |
| 7 | 0.0452 | 0.0453 | 0.0458 | 0.0451 | 0.0462 | 0.0459 | 0.0463 |
| 8 | 0.0453 | 0.0448 | 0.0454 | 0.0451 | 0.0457 | 0.0448 | 0.0452 |
| 9 | 0.0451 | 0.0449 | 0.0448 | 0.0453 | 0.0464 | 0.0450 | 0.0453 |
| 10 | 0.0456 | 0.0462 | 0.0452 | 0.0466 | 0.0450 | 0.0464 | 0.0463 |
| 11 | 0.0449 | 0.0445 | 0.0443 | 0.0440 | 0.0448 | 0.0446 | 0.0447 |
| 12 | 0.0443 | 0.0442 | 0.0456 | 0.0448 | 0.0445 | 0.0460 | 0.0455 |
| 13 | 0.0448 | 0.0450 | 0.0454 | 0.0452 | 0.0451 | 0.0449 | 0.0451 |
| 14 | 0.0456 | 0.0459 | 0.0446 | 0.0454 | 0.0441 | 0.0456 | 0.0463 |
| 15\* | 0.0452 | 0.0455 | 0.0499 | 0.0454 | 0.0457 | 0.0456 | 0.0454 |
| 16\* | 0.0451 | 0.0462 | 0.0474 | 0.0494 | 0.0482 | 0.0473 | 0.0487 |
| 17 | 0.0460 | 0.0450 | 0.0455 | 0.0447 | 0.0449 | 0.0451 | 0.0456 |
| 18 | 0.0461 | 0.0451 | 0.0446 | 0.0452 | 0.0458 | 0.0457 | 0.0450 |