



# 中华人民共和国国家标准

GB/T 18449.1—2001  
neq ISO 4545:1993

---

## 金属努氏硬度试验 第 1 部分:试验方法

Metallic knoop hardness test  
—Part 1: Test method

2001-09-15 发布

2002-02-01 实施



中华人民共和国  
国家质量监督检验检疫总局 发布

中 华 人 民 共 和 国  
国 家 标 准  
金属努氏硬度试验  
第 1 部分:试验方法  
GB/T 18449.1—2001

\*

中国标准出版社出版  
北京复兴门外三里河北街 16 号  
邮政编码:100045

电话:68523946 68517548

中国标准出版社秦皇岛印刷厂印刷  
新华书店北京发行所发行 各地新华书店经售

\*

开本 880×1230 1/16 印张 2 字数 54 千字  
2002 年 2 月第一版 2002 年 2 月第一次印刷  
印数 1—3 000

\*

书号: 155066·1-18111 定价 15.00 元  
网址 [www.bzcbbs.com](http://www.bzcbbs.com)

\*

科 目 595—556

版权专有 侵权必究  
举报电话:(010)68533533

## 前 言

本标准非等效采用国际标准 ISO 4545:1993《金属材料 努氏硬度试验》。

本标准与 ISO 4545 区别如下:

——本标准增加了前言;

——为了保持本标准与国际标准中引用的标准内容完全一致,本标准在对努氏硬度计的要求中引用的 GB/T 18449.2《金属努氏硬度试验 第2部分:硬度计的检验》与 ISO 4546《金属努氏硬度试验 硬度计的检验》等同;

——本标准增加了附录 A《在平面上试验用努氏硬度值表》,它与 ISO 10250《在平面上试验用努氏硬度值表》完全相同。

GB/T 18449《金属努氏硬度试验》分为如下三部分:

——第1部分:试验方法

——第2部分:硬度计的检验

——第3部分:标准硬度块的标定

本标准的附录 A 是标准的附录。

本标准由国家冶金工业局提出。

本标准由全国钢标准化技术委员会归口。

本标准起草单位:钢铁研究总院。

本标准主要起草人:李久林、梁新邦。

## ISO 前言

ISO(国际标准化组织)是由各国国际标准化团体(ISO 成员团体)组成的世界性的联合会。制定国际标准的工作通常由 ISO 的技术委员会完成,各成员团体若对某技术委员会已确立的项目感兴趣,均有权参加该技术委员会。与 ISO 保持联系的各国际组织(官方的或非官方的)也参加工作。在电工技术标准化方面 ISO 与国际电工委员会(IEC)保持密切合作关系。

由技术委员会通过的国际标准草案提交各成员团体表决,国际标准需要取得至少 75% 参加投票表决的成员团体的同意才能正式发布。

国际标准 ISO 4545 由 ISO/TC 164 金属力学性能试验技术委员会 SC 3 硬度试验分委员会制定。

# 中华人民共和国国家标准

## 金属努氏硬度试验 第1部分:试验方法

GB/T 18449.1—2001  
neq ISO 4545:1993

### Metallic knoop hardness test —Part 1: Test method

#### 1 范围

本标准规定了金属材料努氏硬度试验方法。本标准使用的最大试验力为 9.807 N。

#### 2 引用标准

下列标准所包含的条文,通过在本标准中引用而构成为本标准的条文。本标准出版时,所示版本均为有效。所有标准都会被修订,使用本标准的各方应探讨使用下列标准最新版本的可能性。

GB/T 18449.2—2001 金属努氏硬度试验 第2部分:硬度计的检验(idt ISO 4546:1993)

#### 3 原理

将顶部两相对面具有规定角度的菱形棱锥体金刚石压头用试验力压入试样表面,经规定保持时间后卸除试验力,测量试样表面压痕长对角线的长度(见图1和图2)。

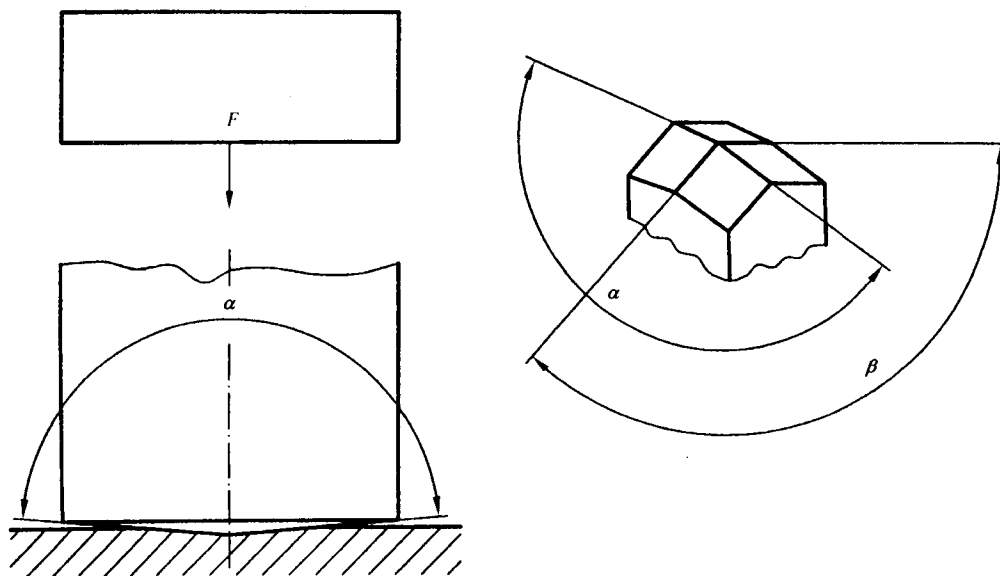


图1 努氏硬度压头

努氏硬度与试验力除以压痕投影面积所得的商成正比,压痕被视为具有与压头顶部角度相同的菱形基面棱锥体形状。

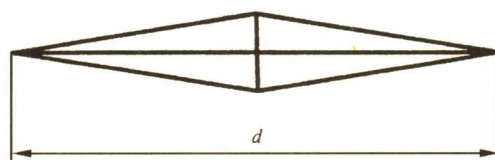


图 2 努氏硬度压痕

## 4 符号及说明

4.1 符号及说明见表 1 及图 1 和图 2。

表 1

| 符 号                                                                                                                                                          | 说 明                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| $F$                                                                                                                                                          | 试验力,单位为 N                                                                                                                                          |
| $d$                                                                                                                                                          | 压痕长对角线长度,单位为 mm                                                                                                                                    |
| $c$                                                                                                                                                          | 压头常数,与用长对角线长度的平方计算的压痕投影面积相关                                                                                                                        |
| HK                                                                                                                                                           | 努氏硬度 = 常数 $\times \frac{\text{试验力}}{\text{压痕投影面积}} = 0.102 \times \frac{F}{d^2 \cdot c} = 0.102 \times \frac{F}{0.7028 d^2} = 1.451 \frac{F}{d^2}$ |
| 注: 常数 $= \frac{1}{c} = \frac{1}{9.80665} \approx 0.102$<br>压头常数 $c = \frac{\tan \frac{\beta}{2}}{2 \tan \frac{\alpha}{2}}$<br>$\alpha$ 及 $\beta$ 是相对棱边之间的夹角。 |                                                                                                                                                    |

4.2 努氏硬度用 HK 表示,符号之前为硬度值,符号之后按如下顺序排列:

- a) 表示试验力的数字(见表 2);
- b) 与 7.4 条规定不同的试验力保持时间,单位为 s。

示例:

640HK0.1 表示在试验力为 0.980 7 N 下保持 10 s~15 s 测定的努氏硬度值为 640。

640HK0.1/20 表示在试验力为 0.980 7 N 下保持 20 s 测定的努氏硬度值为 640。

## 5 试验装置

- 5.1 硬度计应符合 GB/T 18449.2 的规定,并能施加预定力或  $98.07 \times 10^{-3} \text{ N} \sim 9.807 \text{ N}$  的试验力。
- 5.2 压头应是具有菱形基面的金刚石棱锥体,并符合 GB/T 18449.2 的规定。
- 5.3 努氏硬度压痕测量装置应符合 GB/T 18449.2 的相应要求。

## 6 试样

- 6.1 应在平坦光滑的试样表面上进行试验,试样表面应抛光,并应无氧化皮及外来污物,尤其不应有油脂。在各种试验条件下,压痕周边均应清晰地出现在显微镜视场中。
- 6.2 由于努氏硬度压痕很浅,制备试样时应采取措施,使例如由于发热或冷加工等因素对试样表面硬度的影响减至最小。
- 6.3 试验后试样背面不应出现可见变形。
- 6.4 对于小横截面或形状不规则的试样,可使用专用支承台,例如在塑料中镶嵌。

## 7 试验方法

7.1 试验一般在  $23\text{ }^{\circ}\text{C}\pm 5\text{ }^{\circ}\text{C}$  室温下进行,如果不在此温度范围内试验,应在报告中注明。

7.2 推荐选用表 2 中示出的试验力进行试验。

表 2

| 硬 度 符 号 | 试验力 $F/\text{N}$      |
|---------|-----------------------|
| HK0.01  | $98.07\times 10^{-3}$ |
| HK0.02  | 0.196 1               |
| HK0.025 | 0.245 2               |
| HK0.05  | 0.490 3               |
| HK0.1   | 0.980 7               |
| HK0.2   | 1.961                 |
| HK0.3   | 2.942                 |
| HK0.5   | 4.903                 |
| HK1     | 9.807                 |

7.3 试样应放置于刚性支承台上。试样支承面应清洁且无其他污物(氧化皮、油脂、灰尘等)。试样应稳固地放置于支承台上以确保试验中不产生位移。压痕对角线端部必需能清晰地显示出。

7.4 使压头与试样表面接触,垂直于试验面施加试验力,加力过程中不应有冲击和振动,直至将试验力施加至规定值。从加力开始至全部试验力施加完毕的时间应不超过 10 s。压头下降速度应在  $15\text{ }\mu\text{m/s}\sim 70\text{ }\mu\text{m/s}$  之间。试验力保持时间为 10 s~15 s。对于特殊材料,试验力保持时间可以延长,但误差应在  $\pm 2\text{ s}$  之内。

7.5 在整个试验期间,硬度计应避免受到冲击和振动。

7.6 任一压痕边界距试样边缘的距离,对于钢、铜及铜合金至少应为压痕短对角线长度的 2.5 倍;对于轻金属、铅、锡及合金至少应为压痕短对角线长度的 3 倍。

两相邻压痕之间的距离,对于钢、铜及铜合金至少应为压痕短对角线长度的 3 倍;对于轻金属、铅、锡及合金至少应为压痕短对角线长度的 6 倍。如果相邻两压痕大小不同,应以较大压痕确定压痕间距。

7.7 应测量压痕长对角线的长度,用长对角线的长度计算努氏硬度。

7.8 附录 A(标准的附录)是平面上试验用努氏硬度值表。

## 8 试验报告

试验报告应包括如下内容:

- 本国家标准编号;
- 与试样有关的详细资料;
- 试验结果;
- 不在本标准规定之内的各种操作;
- 可能影响试验结果的各种细节。

注

- 尚无普遍通用的方法将努氏硬度精确地换算成其他硬度或抗拉强度。因此应避免这种换算,除非通过对比试验建立换算的基础。
- 仅在试验力相同的条件下,才可以对硬度值作精确比较。

附 录 A  
(标准的附录)  
平面努氏硬度值计算表

表 A1

| 压痕对角线<br><i>d</i> /mm | 试验力/N      |            |             |            |           |           |           |           |         |
|-----------------------|------------|------------|-------------|------------|-----------|-----------|-----------|-----------|---------|
|                       | 0.098 07   | 0.196 1    | 0.245 2     | 0.490 3    | 0.980 7   | 1.961 2   | 2.942 0   | 4.903     | 9.807   |
|                       | 努氏硬度       |            |             |            |           |           |           |           |         |
|                       | HK<br>0.01 | HK<br>0.02 | HK<br>0.025 | HK<br>0.05 | HK<br>0.1 | HK<br>0.2 | HK<br>0.3 | HK<br>0.5 | HK<br>1 |
| 0.020 0               | 355.8      | 711.3      | 889.5       | 1 779      | —         | —         | —         | —         | —       |
| 0.020 2               | 348.7      | 697.2      | 872.0       | 1 743      | —         | —         | —         | —         | —       |
| 0.020 4               | 341.9      | 683.6      | 855.0       | 1 709      | —         | —         | —         | —         | —       |
| 0.020 6               | 335.3      | 670.4      | 838.4       | 1 676      | —         | —         | —         | —         | —       |
| 0.020 8               | 328.9      | 657.6      | 822.4       | 1 644      | —         | —         | —         | —         | —       |
| 0.021 0               | 322.7      | 645.1      | 806.8       | 1 613      | —         | —         | —         | —         | —       |
| 0.021 2               | 316.6      | 633.0      | 791.7       | 1 583      | —         | —         | —         | —         | —       |
| 0.021 4               | 310.7      | 621.2      | 776.9       | 1 553      | —         | —         | —         | —         | —       |
| 0.021 6               | 305.0      | 609.8      | 762.6       | 1 525      | —         | —         | —         | —         | —       |
| 0.021 8               | 299.4      | 598.6      | 748.7       | 1 497      | 2 994     | —         | —         | —         | —       |
| 0.022 0               | 294.0      | 587.8      | 735.1       | 1 470      | 2 940     | —         | —         | —         | —       |
| 0.022 2               | 288.7      | 577.3      | 721.9       | 1 443      | 2 887     | —         | —         | —         | —       |
| 0.022 4               | 283.6      | 567.0      | 709.1       | 1 418      | 2 836     | —         | —         | —         | —       |
| 0.022 6               | 278.6      | 557.0      | 696.6       | 1 393      | 2 786     | —         | —         | —         | —       |
| 0.022 8               | 273.7      | 547.3      | 684.4       | 1 368      | 2 737     | —         | —         | —         | —       |
| 0.023 0               | 269.0      | 537.8      | 672.6       | 1 345      | 2 690     | —         | —         | —         | —       |
| 0.023 2               | 264.4      | 528.6      | 661.0       | 1 322      | 2 644     | —         | —         | —         | —       |
| 0.023 4               | 259.9      | 519.6      | 649.8       | 1 299      | 2 599     | —         | —         | —         | —       |
| 0.023 6               | 255.5      | 510.8      | 638.8       | 1 277      | 2 555     | —         | —         | —         | —       |
| 0.023 8               | 251.2      | 502.3      | 628.1       | 1 256      | 2 512     | —         | —         | —         | —       |
| 0.024 0               | 247.0      | 493.9      | 617.7       | 1 235      | 2 470     | —         | —         | —         | —       |
| 0.024 2               | 243.0      | 485.8      | 607.5       | 1 215      | 2 430     | —         | —         | —         | —       |
| 0.024 4               | 239.0      | 477.9      | 597.6       | 1 195      | 2 390     | —         | —         | —         | —       |
| 0.024 6               | 235.1      | 470.1      | 587.9       | 1 176      | 2 351     | —         | —         | —         | —       |
| 0.024 8               | 231.4      | 462.6      | 578.5       | 1 157      | 2 314     | —         | —         | —         | —       |
| 0.025 0               | 227.7      | 455.2      | 569.3       | 1 138      | 2 277     | —         | —         | —         | —       |
| 0.025 2               | 224.1      | 448.0      | 560.3       | 1 120      | 2 241     | —         | —         | —         | —       |
| 0.025 4               | 220.6      | 441.0      | 551.5       | 1 103      | 2 206     | —         | —         | —         | —       |
| 0.025 6               | 217.1      | 434.1      | 542.9       | 1 086      | 2 171     | —         | —         | —         | —       |
| 0.025 8               | 213.8      | 427.4      | 534.5       | 1 069      | 2 138     | —         | —         | —         | —       |
| 0.026 0               | 210.5      | 420.9      | 526.3       | 1 052      | 2 105     | —         | —         | —         | —       |
| 0.026 2               | 207.3      | 414.5      | 518.3       | 1 036      | 2 073     | —         | —         | —         | —       |
| 0.026 4               | 204.2      | 408.2      | 510.5       | 1 021      | 2 042     | —         | —         | —         | —       |
| 0.026 6               | 201.1      | 402.1      | 502.9       | 1 005      | 2 011     | —         | —         | —         | —       |
| 0.026 8               | 198.1      | 396.1      | 495.4       | 990.5      | 1 981     | —         | —         | —         | —       |



表 A1(续)

| 压痕对角线<br>$d/mm$ | 试验力/N      |            |             |            |           |           |           |           |         |
|-----------------|------------|------------|-------------|------------|-----------|-----------|-----------|-----------|---------|
|                 | 0.098 07   | 0.196 1    | 0.245 2     | 0.490 3    | 0.980 7   | 1.961 2   | 2.942 0   | 4.903     | 9.807   |
|                 | 努氏硬度       |            |             |            |           |           |           |           |         |
|                 | HK<br>0.01 | HK<br>0.02 | HK<br>0.025 | HK<br>0.05 | HK<br>0.1 | HK<br>0.2 | HK<br>0.3 | HK<br>0.5 | HK<br>1 |
| 0.027 0         | 195.2      | 390.3      | 488.1       | 975.9      | 1 952     | —         | —         | —         | —       |
| 0.027 2         | 192.3      | 384.5      | 480.9       | 961.6      | 1 923     | —         | —         | —         | —       |
| 0.027 4         | 189.5      | 378.9      | 473.9       | 947.6      | 1 895     | —         | —         | —         | —       |
| 0.027 6         | 186.8      | 373.5      | 467.1       | 933.9      | 1 868     | —         | —         | —         | —       |
| 0.027 8         | 184.1      | 368.1      | 460.4       | 920.5      | 1 841     | —         | —         | —         | —       |
| 0.028 0         | 181.5      | 362.9      | 453.8       | 907.4      | 1 815     | —         | —         | —         | —       |
| 0.028 2         | 178.9      | 357.8      | 447.4       | 894.6      | 1 789     | —         | —         | —         | —       |
| 0.028 4         | 176.4      | 352.7      | 441.1       | 882.0      | 1 764     | —         | —         | —         | —       |
| 0.028 6         | 174.0      | 347.8      | 435.0       | 869.7      | 1 740     | —         | —         | —         | —       |
| 0.028 8         | 171.6      | 343.0      | 429.0       | 857.7      | 1 716     | —         | —         | —         | —       |
| 0.029 0         | 169.2      | 338.3      | 423.1       | 845.9      | 1 692     | —         | —         | —         | —       |
| 0.029 2         | 166.9      | 333.7      | 417.3       | 834.3      | 1 669     | —         | —         | —         | —       |
| 0.029 4         | 164.6      | 329.1      | 411.6       | 823.0      | 1 646     | —         | —         | —         | —       |
| 0.029 6         | 162.4      | 324.7      | 406.1       | 812.0      | 1 624     | —         | —         | —         | —       |
| 0.029 8         | 160.2      | 320.4      | 400.7       | 801.1      | 1 602     | —         | —         | —         | —       |
| 0.030 0         | 158.1      | 316.1      | 395.3       | 790.4      | 1 581     | —         | —         | —         | —       |
| 0.030 2         | 156.0      | 311.9      | 390.1       | 780.0      | 1 560     | —         | —         | —         | —       |
| 0.030 4         | 154.0      | 307.8      | 385.0       | 769.8      | 1 540     | —         | —         | —         | —       |
| 0.030 6         | 152.0      | 303.8      | 380.0       | 759.8      | 1 520     | —         | —         | —         | —       |
| 0.030 8         | 150.0      | 299.9      | 375.1       | 749.9      | 1 500     | 2 999     | —         | —         | —       |
| 0.031 0         | 148.1      | 296.0      | 370.2       | 740.3      | 1 481     | 2 960     | —         | —         | —       |
| 0.031 2         | 146.2      | 292.3      | 365.5       | 730.8      | 1 462     | 2 923     | —         | —         | —       |
| 0.031 4         | 144.3      | 288.6      | 360.9       | 721.5      | 1 443     | 2 886     | —         | —         | —       |
| 0.031 6         | 142.5      | 284.9      | 356.3       | 712.4      | 1 425     | 2 849     | —         | —         | —       |
| 0.031 8         | 140.7      | 281.3      | 351.8       | 703.5      | 1 407     | 2 813     | —         | —         | —       |
| 0.032 0         | 139.0      | 277.8      | 347.5       | 694.7      | 1 390     | 2 778     | —         | —         | —       |
| 0.032 2         | 137.2      | 274.4      | 343.2       | 686.1      | 1 372     | 2 744     | —         | —         | —       |
| 0.032 4         | 135.6      | 271.0      | 338.9       | 677.7      | 1 356     | 2 710     | —         | —         | —       |
| 0.032 6         | 133.9      | 267.7      | 334.8       | 669.4      | 1 339     | 2 677     | —         | —         | —       |
| 0.032 8         | 132.3      | 264.4      | 330.7       | 661.3      | 1 323     | 2 644     | —         | —         | —       |
| 0.033 0         | 130.7      | 261.2      | 326.7       | 653.3      | 1 307     | 2 612     | —         | —         | —       |
| 0.033 2         | 129.1      | 258.1      | 322.8       | 645.4      | 1 291     | 2 581     | —         | —         | —       |
| 0.033 4         | 127.6      | 255.0      | 318.9       | 637.7      | 1 276     | 2 550     | —         | —         | —       |
| 0.033 6         | 126.0      | 252.0      | 315.2       | 630.1      | 1 260     | 2 520     | —         | —         | —       |
| 0.033 8         | 124.6      | 249.0      | 311.4       | 622.7      | 1 246     | 2 490     | —         | —         | —       |
| 0.034 0         | 123.1      | 246.1      | 307.8       | 615.4      | 1 231     | 2 461     | —         | —         | —       |
| 0.034 2         | 121.7      | 243.2      | 304.2       | 608.2      | 1 217     | 2 432     | —         | —         | —       |
| 0.034 4         | 120.3      | 240.4      | 300.7       | 601.2      | 1 203     | 2 404     | —         | —         | —       |
| 0.034 6         | 118.9      | 237.6      | 297.2       | 594.2      | 1 189     | 2 376     | —         | —         | —       |
| 0.034 8         | 117.5      | 234.9      | 293.8       | 587.4      | 1 175     | 2 349     | —         | —         | —       |

表 A1(续)

| 压痕对角线<br>$d/mm$ | 试验力/N      |            |             |            |           |           |           |           |         |
|-----------------|------------|------------|-------------|------------|-----------|-----------|-----------|-----------|---------|
|                 | 0.098 07   | 0.196 1    | 0.245 2     | 0.490 3    | 0.980 7   | 1.961 2   | 2.942 0   | 4.903     | 9.807   |
|                 | 努氏硬度       |            |             |            |           |           |           |           |         |
|                 | HK<br>0.01 | HK<br>0.02 | HK<br>0.025 | HK<br>0.05 | HK<br>0.1 | HK<br>0.2 | HK<br>0.3 | HK<br>0.5 | HK<br>1 |
| 0.035 0         | 116.2      | 232.2      | 290.4       | 580.7      | 1 162     | 2 322     | —         | —         | —       |
| 0.035 2         | 114.8      | 229.6      | 287.2       | 574.2      | 1 148     | 2 296     | —         | —         | —       |
| 0.035 4         | 113.0      | 227.0      | 283.9       | 567.7      | 1 136     | 2 270     | —         | —         | —       |
| 0.035 6         | 112.3      | 224.5      | 280.7       | 561.3      | 1 123     | 2 245     | —         | —         | —       |
| 0.035 8         | 111.0      | 222.0      | 277.6       | 555.1      | 1 110     | 2 220     | —         | —         | —       |
| 0.036 0         | 109.8      | 219.5      | 274.5       | 548.9      | 1 098     | 2 195     | —         | —         | —       |
| 0.036 2         | 108.6      | 217.1      | 271.5       | 542.9      | 1 086     | 2 171     | —         | —         | —       |
| 0.036 4         | 107.4      | 214.7      | 268.5       | 536.9      | 1 074     | 2 147     | —         | —         | —       |
| 0.036 6         | 106.2      | 212.4      | 265.6       | 531.1      | 1 062     | 2 124     | —         | —         | —       |
| 0.036 8         | 105.1      | 210.1      | 262.7       | 525.3      | 1 051     | 2 101     | —         | —         | —       |
| 0.037 0         | 103.9      | 207.8      | 259.9       | 519.6      | 1 039     | 2 078     | —         | —         | —       |
| 0.037 2         | 102.8      | 205.6      | 257.1       | 514.1      | 1 028     | 2 056     | —         | —         | —       |
| 0.037 4         | 101.7      | 203.4      | 254.4       | 508.6      | 1 017     | 2 034     | —         | —         | —       |
| 0.037 6         | 100.7      | 201.2      | 251.7       | 503.2      | 1 007     | 2 012     | —         | —         | —       |
| 0.037 8         | 99.59      | 199.1      | 249.0       | 497.9      | 995.9     | 1 991     | 2 988     | —         | —       |
| 0.038 0         | 98.55      | 197.0      | 246.4       | 492.7      | 985.5     | 1 970     | 2 956     | —         | —       |
| 0.038 2         | 97.52      | 195.0      | 243.8       | 487.5      | 975.2     | 1 950     | 2 925     | —         | —       |
| 0.038 4         | 96.50      | 192.9      | 241.3       | 482.4      | 965.0     | 1 929     | 2 895     | —         | —       |
| 0.038 6         | 95.51      | 190.9      | 238.8       | 477.5      | 955.1     | 1 909     | 2 865     | —         | —       |
| 0.038 8         | 94.52      | 189.0      | 236.3       | 472.6      | 945.2     | 1 890     | 2 836     | —         | —       |
| 0.039 0         | 93.56      | 187.0      | 233.9       | 467.7      | 935.6     | 1 870     | 2 807     | —         | —       |
| 0.039 2         | 92.60      | 185.1      | 231.5       | 463.0      | 926.0     | 1 851     | 2 778     | —         | —       |
| 0.039 4         | 91.67      | 183.3      | 229.2       | 458.3      | 916.7     | 1 833     | 2 750     | —         | —       |
| 0.039 6         | 90.74      | 181.4      | 226.9       | 453.7      | 907.4     | 1 814     | 2 722     | —         | —       |
| 0.039 8         | 89.83      | 179.6      | 224.6       | 449.1      | 898.3     | 1 796     | 2 695     | —         | —       |
| 0.040 0         | 88.94      | 177.8      | 222.4       | 444.6      | 889.4     | 1 778     | 2 668     | —         | —       |
| 0.040 2         | 88.05      | 176.0      | 220.2       | 440.2      | 880.5     | 1 760     | 2 642     | —         | —       |
| 0.040 4         | 87.19      | 174.3      | 218.0       | 435.9      | 871.9     | 1 743     | 2 616     | —         | —       |
| 0.040 6         | 86.33      | 172.6      | 215.9       | 431.6      | 863.3     | 1 726     | 2 590     | —         | —       |
| 0.040 8         | 85.48      | 170.9      | 213.7       | 427.4      | 854.8     | 1 709     | 2 565     | —         | —       |
| 0.041 0         | 84.65      | 169.2      | 211.7       | 423.2      | 846.5     | 1 692     | 2 540     | —         | —       |
| 0.041 2         | 83.83      | 167.6      | 209.6       | 419.1      | 838.3     | 1 676     | 2 515     | —         | —       |
| 0.041 4         | 83.02      | 166.0      | 207.6       | 415.1      | 830.2     | 1 660     | 2 491     | —         | —       |
| 0.041 6         | 82.23      | 164.4      | 205.6       | 411.1      | 822.3     | 1 644     | 2 467     | —         | —       |
| 0.041 8         | 81.44      | 162.8      | 203.6       | 407.2      | 814.4     | 1 628     | 2 443     | —         | —       |
| 0.042 0         | 80.67      | 161.3      | 201.7       | 403.3      | 806.7     | 1 613     | 2 420     | —         | —       |
| 0.042 2         | 79.91      | 159.8      | 199.8       | 399.5      | 799.1     | 1 598     | 2 397     | —         | —       |
| 0.042 4         | 79.15      | 158.3      | 197.9       | 395.7      | 791.5     | 1 583     | 2 375     | —         | —       |
| 0.042 6         | 78.41      | 156.8      | 196.1       | 392.0      | 784.1     | 1 568     | 2 352     | —         | —       |
| 0.042 8         | 77.68      | 155.3      | 194.2       | 388.4      | 776.8     | 1 553     | 2 330     | —         | —       |

表 A1(续)

| 压痕对角线<br>$d/mm$ | 试验力/N      |            |             |            |           |           |           |           |         |
|-----------------|------------|------------|-------------|------------|-----------|-----------|-----------|-----------|---------|
|                 | 0.098 07   | 0.196 1    | 0.245 2     | 0.490 3    | 0.980 7   | 1.961 2   | 2.942 0   | 4.903     | 9.807   |
|                 | 努氏硬度       |            |             |            |           |           |           |           |         |
|                 | HK<br>0.01 | HK<br>0.02 | HK<br>0.025 | HK<br>0.05 | HK<br>0.1 | HK<br>0.2 | HK<br>0.3 | HK<br>0.5 | HK<br>1 |
| 0.043 0         | 76.96      | 153.9      | 192.4       | 384.7      | 769.6     | 1 539     | 2 309     | —         | —       |
| 0.043 2         | 76.25      | 152.4      | 190.7       | 381.2      | 762.5     | 1 524     | 2 287     | —         | —       |
| 0.043 4         | 75.55      | 151.0      | 188.9       | 377.7      | 755.5     | 1 510     | 2 266     | —         | —       |
| 0.043 6         | 74.86      | 149.7      | 187.2       | 374.2      | 748.6     | 1 497     | 2 246     | —         | —       |
| 0.043 8         | 74.17      | 148.3      | 185.5       | 370.8      | 741.7     | 1 483     | 2 225     | —         | —       |
| 0.044 0         | 73.50      | 147.0      | 183.8       | 367.5      | 735.0     | 1 470     | 2 205     | —         | —       |
| 0.044 2         | 72.84      | 145.6      | 182.1       | 364.1      | 728.4     | 1 456     | 2 185     | —         | —       |
| 0.044 4         | 72.18      | 144.3      | 180.5       | 360.9      | 721.8     | 1 443     | 2 166     | —         | —       |
| 0.044 6         | 71.54      | 143.0      | 178.9       | 357.6      | 715.4     | 1 430     | 2 146     | —         | —       |
| 0.044 8         | 70.90      | 141.8      | 177.3       | 354.5      | 709.0     | 1 418     | 2 127     | —         | —       |
| 0.045 0         | 70.27      | 140.5      | 175.7       | 351.3      | 702.7     | 1 405     | 2 108     | —         | —       |
| 0.045 2         | 69.65      | 139.3      | 174.2       | 348.2      | 696.5     | 1 393     | 2 090     | —         | —       |
| 0.045 4         | 69.04      | 138.0      | 172.6       | 345.1      | 690.4     | 1 380     | 2 071     | —         | —       |
| 0.045 6         | 68.43      | 136.8      | 171.1       | 342.1      | 684.3     | 1 368     | 2 053     | —         | —       |
| 0.045 8         | 67.84      | 135.6      | 169.6       | 339.1      | 678.4     | 1 356     | 2 035     | —         | —       |
| 0.046 0         | 67.25      | 134.5      | 168.1       | 336.2      | 672.5     | 1 345     | 2 017     | —         | —       |
| 0.046 2         | 66.67      | 133.3      | 166.7       | 333.3      | 666.7     | 1 333     | 2 000     | —         | —       |
| 0.046 4         | 66.10      | 132.1      | 165.3       | 330.4      | 661.0     | 1 321     | 1 983     | —         | —       |
| 0.046 6         | 65.53      | 131.0      | 163.8       | 327.6      | 655.3     | 1 310     | 1 966     | —         | —       |
| 0.046 8         | 64.97      | 129.9      | 162.4       | 324.8      | 649.7     | 1 299     | 1 949     | —         | —       |
| 0.047 0         | 64.42      | 128.8      | 161.1       | 322.0      | 644.2     | 1 288     | 1 933     | —         | —       |
| 0.047 2         | 63.87      | 127.7      | 159.7       | 319.3      | 638.7     | 1 277     | 1 916     | —         | —       |
| 0.047 4         | 63.34      | 126.6      | 158.4       | 316.6      | 633.4     | 1 266     | 1 900     | —         | —       |
| 0.047 6         | 62.80      | 125.6      | 157.0       | 314.0      | 628.0     | 1 256     | 1 884     | —         | —       |
| 0.047 8         | 62.28      | 124.5      | 155.7       | 311.4      | 622.8     | 1 245     | 1 868     | —         | —       |
| 0.048 0         | 61.76      | 123.5      | 154.4       | 308.8      | 617.6     | 1 235     | 1 853     | —         | —       |
| 0.048 2         | 61.25      | 122.5      | 153.1       | 306.2      | 612.5     | 1 225     | 1 838     | —         | —       |
| 0.048 4         | 60.75      | 121.4      | 151.9       | 303.7      | 607.5     | 1 214     | 1 822     | —         | —       |
| 0.048 6         | 60.25      | 120.5      | 150.6       | 301.2      | 602.5     | 1 205     | 1 807     | —         | —       |
| 0.048 8         | 59.75      | 119.5      | 149.4       | 298.7      | 597.5     | 1 195     | 1 793     | 2 987     | —       |
| 0.049 0         | 59.27      | 118.5      | 148.2       | 296.3      | 592.7     | 1 185     | 1 778     | 2 963     | —       |
| 0.049 2         | 58.79      | 117.5      | 147.0       | 293.9      | 587.9     | 1 175     | 1 764     | 2 939     | —       |
| 0.049 4         | 58.31      | 116.6      | 145.8       | 291.5      | 583.1     | 1 166     | 1 749     | 2 915     | —       |
| 0.049 6         | 57.84      | 115.6      | 144.6       | 289.2      | 578.4     | 1 156     | 1 735     | 2 892     | —       |
| 0.049 8         | 57.38      | 114.7      | 143.5       | 286.9      | 573.8     | 1 147     | 1 721     | 2 869     | —       |
| 0.050 0         | 56.92      | 113.8      | 142.3       | 284.6      | 569.2     | 1 138     | 1 708     | 2 846     | —       |
| 0.050 2         | 56.47      | 112.9      | 141.2       | 282.3      | 564.7     | 1 129     | 1 694     | 2 823     | —       |
| 0.050 4         | 56.02      | 112.0      | 140.1       | 280.1      | 560.2     | 1 120     | 1 681     | 2 801     | —       |
| 0.050 6         | 55.58      | 111.1      | 139.0       | 277.9      | 555.8     | 1 111     | 1 667     | 2 779     | —       |
| 0.050 8         | 55.14      | 110.2      | 137.9       | 275.7      | 551.4     | 1 102     | 1 654     | 2 757     | —       |

表 A1(续)

| 压痕对角线<br><i>d</i> /mm | 试验力/ <i>N</i> |            |             |            |           |           |           |           |         |
|-----------------------|---------------|------------|-------------|------------|-----------|-----------|-----------|-----------|---------|
|                       | 0.098 07      | 0.196 1    | 0.245 2     | 0.490 3    | 0.980 7   | 1.961 2   | 2.942 0   | 4.903     | 9.807   |
|                       | 努氏硬度          |            |             |            |           |           |           |           |         |
|                       | HK<br>0.01    | HK<br>0.02 | HK<br>0.025 | HK<br>0.05 | HK<br>0.1 | HK<br>0.2 | HK<br>0.3 | HK<br>0.5 | HK<br>1 |
| 0.051 0               | 54.71         | 109.4      | 136.8       | 273.5      | 547.1     | 1 094     | 1 641     | 2 735     | —       |
| 0.051 2               | 54.28         | 108.5      | 135.7       | 271.4      | 542.8     | 1 085     | 1 628     | 2 714     | —       |
| 0.051 4               | 53.86         | 107.7      | 134.7       | 269.3      | 538.6     | 1 077     | 1 616     | 2 693     | —       |
| 0.051 6               | 53.44         | 106.9      | 133.6       | 267.2      | 534.4     | 1 069     | 1 603     | 2 672     | —       |
| 0.051 8               | 53.03         | 106.0      | 132.6       | 265.1      | 530.3     | 1 060     | 1 591     | 2 651     | —       |
| 0.052 0               | 52.63         | 105.2      | 131.6       | 263.1      | 526.3     | 1 052     | 1 579     | 2 631     | —       |
| 0.052 2               | 52.22         | 104.4      | 130.6       | 261.1      | 522.2     | 1 044     | 1 567     | 2 611     | —       |
| 0.052 4               | 51.83         | 103.6      | 129.6       | 259.1      | 518.3     | 1 036     | 1 555     | 2 591     | —       |
| 0.052 6               | 51.43         | 102.8      | 128.6       | 257.1      | 514.3     | 1 028     | 1 543     | 2 571     | —       |
| 0.052 8               | 51.04         | 102.1      | 127.6       | 255.2      | 510.4     | 1 021     | 1 531     | 2 552     | —       |
| 0.053 0               | 50.66         | 101.3      | 126.7       | 253.3      | 506.6     | 1 013     | 1 520     | 2 533     | —       |
| 0.053 2               | 50.28         | 100.5      | 125.7       | 251.4      | 502.8     | 1 005     | 1 508     | 2 514     | —       |
| 0.053 4               | 49.90         | 99.77      | 124.8       | 249.5      | 499.0     | 997.7     | 1 497     | 2 495     | —       |
| 0.053 6               | 49.53         | 99.03      | 123.8       | 247.6      | 495.3     | 990.3     | 1 486     | 2 476     | —       |
| 0.053 8               | 49.16         | 98.29      | 122.9       | 245.8      | 491.6     | 982.9     | 1 475     | 2 458     | —       |
| 0.054 0               | 48.80         | 97.57      | 122.0       | 244.0      | 488.0     | 975.7     | 1 464     | 2 440     | —       |
| 0.054 2               | 48.44         | 96.85      | 121.1       | 242.2      | 484.4     | 968.5     | 1 453     | 2 422     | —       |
| 0.054 4               | 48.08         | 96.14      | 120.2       | 240.4      | 480.8     | 961.4     | 1 443     | 2 404     | —       |
| 0.054 6               | 47.73         | 95.43      | 119.3       | 238.6      | 477.3     | 954.3     | 1 432     | 2 386     | —       |
| 0.054 8               | 47.39         | 94.74      | 118.5       | 236.9      | 473.9     | 947.4     | 1 422     | 2 369     | —       |
| 0.055 0               | 47.04         | 94.05      | 117.6       | 235.2      | 470.4     | 940.5     | 1 411     | 2 352     | —       |
| 0.055 2               | 46.70         | 93.37      | 116.8       | 233.5      | 467.0     | 933.7     | 1 401     | 2 335     | —       |
| 0.055 4               | 46.36         | 92.70      | 115.9       | 231.8      | 463.6     | 927.0     | 1 391     | 2 318     | —       |
| 0.055 6               | 46.03         | 92.03      | 115.1       | 230.1      | 460.3     | 920.3     | 1 381     | 2 301     | —       |
| 0.055 8               | 45.70         | 91.37      | 114.3       | 228.5      | 457.0     | 913.7     | 1 371     | 2 285     | —       |
| 0.056 0               | 45.38         | 90.72      | 113.5       | 226.8      | 453.8     | 907.2     | 1 361     | 2 268     | —       |
| 0.056 2               | 45.05         | 90.08      | 112.7       | 225.2      | 450.5     | 900.8     | 1 352     | 2 252     | —       |
| 0.056 4               | 44.73         | 89.44      | 111.9       | 223.6      | 447.3     | 894.4     | 1 342     | 2 236     | —       |
| 0.056 6               | 44.42         | 88.81      | 111.1       | 222.1      | 444.2     | 888.1     | 1 333     | 2 221     | —       |
| 0.056 8               | 44.11         | 88.18      | 110.3       | 220.5      | 441.1     | 881.8     | 1 323     | 2 205     | —       |
| 0.057 0               | 43.80         | 87.57      | 109.5       | 219.0      | 438.0     | 875.7     | 1 314     | 2 190     | —       |
| 0.057 2               | 43.49         | 86.95      | 108.7       | 217.4      | 434.9     | 869.5     | 1 305     | 2 174     | —       |
| 0.057 4               | 43.19         | 86.35      | 108.0       | 215.9      | 431.9     | 863.5     | 1 296     | 2 159     | —       |
| 0.057 6               | 42.89         | 85.75      | 107.2       | 214.4      | 428.9     | 857.5     | 1 287     | 2 144     | —       |
| 0.057 8               | 42.59         | 85.16      | 106.5       | 212.9      | 425.9     | 851.6     | 1 278     | 2 129     | —       |
| 0.058 0               | 42.30         | 84.57      | 105.8       | 211.5      | 423.0     | 845.7     | 1 269     | 2 115     | —       |
| 0.058 2               | 42.01         | 83.99      | 105.0       | 210.0      | 420.1     | 839.9     | 1 260     | 2 100     | —       |
| 0.058 4               | 41.72         | 83.42      | 104.3       | 208.6      | 417.2     | 834.2     | 1 252     | 2 086     | —       |
| 0.058 6               | 41.44         | 82.85      | 103.6       | 207.2      | 414.4     | 828.5     | 1 243     | 2 072     | —       |
| 0.058 8               | 41.16         | 82.29      | 102.9       | 205.8      | 411.6     | 822.9     | 1 235     | 2 058     | —       |



表 A1(续)

| 压痕对角线<br>$d/mm$ | 试验力/N      |            |             |            |           |           |           |           |         |
|-----------------|------------|------------|-------------|------------|-----------|-----------|-----------|-----------|---------|
|                 | 0.098 07   | 0.196 1    | 0.245 2     | 0.490 3    | 0.980 7   | 1.961 2   | 2.942 0   | 4.903     | 9.807   |
|                 | 努氏硬度       |            |             |            |           |           |           |           |         |
|                 | HK<br>0.01 | HK<br>0.02 | HK<br>0.025 | HK<br>0.05 | HK<br>0.1 | HK<br>0.2 | HK<br>0.3 | HK<br>0.5 | HK<br>1 |
| 0.059 0         | 40.88      | 81.73      | 102.2       | 204.4      | 408.8     | 817.3     | 1 226     | 2 044     | —       |
| 0.059 2         | 40.60      | 81.18      | 101.5       | 203.0      | 406.0     | 811.8     | 1 218     | 2 030     | —       |
| 0.059 4         | 40.33      | 80.63      | 100.8       | 201.6      | 403.3     | 806.3     | 1 210     | 2 016     | —       |
| 0.059 6         | 40.06      | 80.09      | 100.2       | 200.3      | 400.6     | 800.9     | 1 202     | 2 003     | —       |
| 0.059 8         | 39.79      | 79.56      | 99.50       | 198.9      | 397.9     | 795.6     | 1 194     | 1 989     | —       |
| 0.060 0         | 39.53      | 79.03      | 98.83       | 197.6      | 395.3     | 790.3     | 1 186     | 1 976     | —       |
| 0.060 2         | 39.27      | 78.50      | 98.18       | 196.3      | 392.7     | 785.0     | 1 178     | 1 963     | —       |
| 0.060 4         | 39.01      | 77.98      | 97.53       | 195.0      | 390.1     | 779.8     | 1 170     | 1 950     | —       |
| 0.060 6         | 38.75      | 77.47      | 96.89       | 193.7      | 387.5     | 774.7     | 1 162     | 1 937     | —       |
| 0.060 8         | 38.49      | 76.96      | 96.25       | 192.4      | 384.9     | 769.6     | 1 155     | 1 924     | —       |
| 0.061 0         | 38.24      | 76.46      | 95.62       | 191.2      | 382.4     | 764.6     | 1 147     | 1 912     | —       |
| 0.061 2         | 37.99      | 75.96      | 95.00       | 189.9      | 379.9     | 759.6     | 1 140     | 1 899     | —       |
| 0.061 4         | 37.75      | 75.46      | 94.38       | 188.7      | 377.5     | 754.6     | 1 132     | 1 887     | —       |
| 0.061 6         | 37.50      | 74.98      | 93.77       | 187.5      | 375.0     | 749.8     | 1 125     | 1 875     | —       |
| 0.061 8         | 37.26      | 74.49      | 93.16       | 186.3      | 372.6     | 744.9     | 1 118     | 1 863     | —       |
| 0.062 0         | 37.02      | 74.01      | 92.56       | 185.1      | 370.2     | 740.1     | 1 111     | 1 851     | —       |
| 0.062 2         | 36.78      | 73.51      | 91.97       | 183.9      | 367.8     | 735.4     | 1 103     | 1 839     | —       |
| 0.062 4         | 36.55      | 73.07      | 91.38       | 182.7      | 365.5     | 730.7     | 1 096     | 1 827     | —       |
| 0.062 6         | 36.31      | 72.60      | 90.79       | 181.5      | 363.1     | 726.0     | 1 089     | 1 815     | —       |
| 0.062 8         | 36.08      | 72.14      | 90.22       | 180.4      | 360.8     | 721.4     | 1 082     | 1 804     | —       |
| 0.063 0         | 35.85      | 71.68      | 89.64       | 179.2      | 358.5     | 716.8     | 1 076     | 1 792     | —       |
| 0.063 2         | 35.63      | 71.23      | 89.08       | 178.1      | 356.3     | 712.3     | 1 069     | 1 781     | —       |
| 0.063 4         | 35.40      | 70.78      | 88.52       | 177.0      | 354.0     | 707.8     | 1 062     | 1 770     | —       |
| 0.063 6         | 35.18      | 70.33      | 87.96       | 175.9      | 351.8     | 703.3     | 1 055     | 1 759     | —       |
| 0.063 8         | 34.96      | 69.89      | 87.41       | 174.8      | 349.6     | 698.9     | 1 049     | 1 748     | —       |
| 0.064 0         | 34.74      | 69.46      | 86.87       | 173.7      | 347.4     | 694.6     | 1 042     | 1 737     | —       |
| 0.064 2         | 34.53      | 69.03      | 86.32       | 172.6      | 345.3     | 690.3     | 1 036     | 1 726     | —       |
| 0.064 4         | 34.31      | 68.60      | 85.79       | 171.5      | 343.1     | 686.0     | 1 029     | 1 715     | —       |
| 0.064 6         | 34.10      | 68.17      | 85.26       | 170.5      | 341.0     | 681.7     | 1 023     | 1 705     | —       |
| 0.064 8         | 33.89      | 67.75      | 84.73       | 169.4      | 338.9     | 677.5     | 1 017     | 1 694     | —       |
| 0.065 0         | 33.68      | 67.34      | 84.21       | 168.4      | 336.8     | 673.4     | 1 010     | 1 684     | —       |
| 0.065 2         | 33.47      | 66.92      | 83.70       | 167.3      | 334.7     | 669.2     | 1 004     | 1 673     | —       |
| 0.065 4         | 33.27      | 66.52      | 83.19       | 166.3      | 332.7     | 665.2     | 998.1     | 1 663     | —       |
| 0.065 6         | 33.07      | 66.11      | 82.68       | 165.3      | 330.7     | 661.1     | 992.0     | 1 653     | —       |
| 0.065 8         | 32.87      | 65.71      | 82.18       | 164.3      | 328.7     | 657.1     | 986.0     | 1 643     | —       |
| 0.066 0         | 32.67      | 65.31      | 81.68       | 163.3      | 326.7     | 653.1     | 980.0     | 1 633     | —       |
| 0.066 2         | 32.47      | 64.92      | 81.19       | 162.3      | 324.7     | 649.2     | 974.1     | 1 623     | —       |
| 0.066 4         | 32.28      | 64.53      | 80.70       | 161.4      | 322.8     | 645.3     | 968.3     | 1 614     | —       |
| 0.066 6         | 32.08      | 64.14      | 80.22       | 160.4      | 320.8     | 641.4     | 962.4     | 1 604     | —       |
| 0.066 8         | 31.89      | 63.76      | 79.74       | 159.4      | 318.9     | 637.6     | 956.7     | 1 594     | —       |

表 A1(续)

| 压痕对角线<br>$d/mm$ | 试验力/N      |            |             |            |           |           |           |           |         |
|-----------------|------------|------------|-------------|------------|-----------|-----------|-----------|-----------|---------|
|                 | 0.098 07   | 0.196 1    | 0.245 2     | 0.490 3    | 0.980 7   | 1.961 2   | 2.942 0   | 4.903     | 9.807   |
|                 | 努氏硬度       |            |             |            |           |           |           |           |         |
|                 | HK<br>0.01 | HK<br>0.02 | HK<br>0.025 | HK<br>0.05 | HK<br>0.1 | HK<br>0.2 | HK<br>0.3 | HK<br>0.5 | HK<br>1 |
| 0.067 0         | 31.70      | 63.38      | 79.26       | 158.5      | 317.0     | 633.8     | 951.0     | 1 585     | —       |
| 0.067 2         | 31.51      | 63.00      | 78.79       | 157.5      | 315.1     | 630.0     | 945.3     | 1 575     | —       |
| 0.067 4         | 31.32      | 62.63      | 78.32       | 156.6      | 313.2     | 626.3     | 939.7     | 1 566     | —       |
| 0.067 6         | 31.14      | 62.26      | 77.86       | 155.7      | 311.4     | 622.6     | 934.2     | 1 557     | —       |
| 0.067 8         | 30.96      | 61.89      | 77.40       | 154.8      | 309.6     | 618.9     | 928.7     | 1 548     | —       |
| 0.068 0         | 30.77      | 61.53      | 76.95       | 153.8      | 307.7     | 615.3     | 923.2     | 1 538     | —       |
| 0.068 2         | 30.59      | 61.17      | 76.50       | 152.9      | 305.9     | 611.7     | 917.8     | 1 529     | —       |
| 0.068 4         | 30.42      | 60.81      | 76.05       | 152.1      | 304.2     | 608.1     | 912.5     | 1 521     | —       |
| 0.068 6         | 30.24      | 60.46      | 75.61       | 151.2      | 302.4     | 604.6     | 907.1     | 1 512     | —       |
| 0.068 8         | 30.06      | 60.10      | 75.17       | 150.3      | 300.6     | 601.0     | 901.9     | 1 503     | —       |
| 0.069 0         | 29.89      | 59.76      | 74.73       | 149.4      | 298.9     | 597.6     | 896.7     | 1 494     | 2 989   |
| 0.069 2         | 29.72      | 59.41      | 74.30       | 148.6      | 297.2     | 594.1     | 891.5     | 1 486     | 2 972   |
| 0.069 4         | 29.55      | 59.07      | 73.87       | 147.7      | 295.5     | 590.7     | 886.4     | 1 477     | 2 955   |
| 0.069 6         | 29.38      | 58.73      | 73.45       | 146.9      | 293.8     | 587.3     | 881.3     | 1 469     | 2 938   |
| 0.069 8         | 29.21      | 58.39      | 73.03       | 146.0      | 292.1     | 583.9     | 876.2     | 1 460     | 2 921   |
| 0.070 0         | 29.04      | 58.06      | 72.61       | 145.2      | 290.4     | 580.6     | 871.2     | 1 452     | 2 904   |
| 0.070 2         | 28.88      | 57.73      | 72.20       | 144.4      | 288.8     | 577.3     | 866.3     | 1 444     | 2 888   |
| 0.070 4         | 28.71      | 57.40      | 71.79       | 143.5      | 287.1     | 574.0     | 861.4     | 1 435     | 2 871   |
| 0.070 6         | 28.55      | 57.08      | 71.38       | 142.7      | 285.5     | 570.8     | 856.5     | 1 427     | 2 855   |
| 0.070 8         | 28.39      | 56.76      | 70.98       | 141.9      | 283.9     | 567.6     | 851.6     | 1 419     | 2 839   |
| 0.071 0         | 28.23      | 56.44      | 70.58       | 141.1      | 282.3     | 564.4     | 846.9     | 1 411     | 2 823   |
| 0.071 2         | 28.07      | 56.12      | 70.19       | 140.3      | 280.7     | 561.2     | 842.1     | 1 403     | 2 807   |
| 0.071 4         | 27.91      | 55.81      | 69.79       | 139.5      | 279.1     | 558.1     | 837.4     | 1 395     | 2 791   |
| 0.071 6         | 27.76      | 55.50      | 69.40       | 138.8      | 277.6     | 555.0     | 832.7     | 1 388     | 2 776   |
| 0.071 8         | 27.60      | 55.19      | 69.02       | 138.0      | 276.0     | 551.9     | 828.1     | 1 380     | 2 760   |
| 0.072 0         | 27.45      | 54.88      | 68.63       | 137.2      | 274.5     | 548.8     | 823.5     | 1 372     | 2 745   |
| 0.072 2         | 27.30      | 54.58      | 68.25       | 136.5      | 273.0     | 545.8     | 818.9     | 1 365     | 2 730   |
| 0.072 4         | 27.15      | 54.28      | 67.88       | 135.7      | 271.5     | 542.8     | 814.4     | 1 357     | 2 715   |
| 0.072 6         | 27.00      | 53.98      | 67.50       | 135.0      | 270.0     | 539.8     | 809.9     | 1 350     | 2 700   |
| 0.072 8         | 26.85      | 53.68      | 67.13       | 134.2      | 268.5     | 536.8     | 805.5     | 1 342     | 2 685   |
| 0.073 0         | 26.70      | 53.39      | 66.77       | 133.5      | 267.0     | 533.9     | 801.1     | 1 335     | 2 670   |
| 0.073 2         | 26.56      | 53.10      | 66.40       | 132.8      | 265.6     | 531.0     | 796.7     | 1 328     | 2 656   |
| 0.073 4         | 26.41      | 52.81      | 66.04       | 132.0      | 264.1     | 528.1     | 792.4     | 1 320     | 2 641   |
| 0.073 6         | 26.27      | 52.52      | 65.68       | 131.3      | 262.7     | 525.2     | 788.1     | 1 313     | 2 627   |
| 0.073 8         | 26.13      | 52.24      | 65.33       | 130.6      | 261.3     | 522.4     | 783.8     | 1 306     | 2 613   |
| 0.074 0         | 25.99      | 51.95      | 64.97       | 129.9      | 259.9     | 519.5     | 779.6     | 1 299     | 2 599   |
| 0.074 2         | 25.85      | 51.67      | 64.62       | 129.2      | 258.5     | 516.7     | 775.4     | 1 292     | 2 585   |
| 0.074 4         | 25.71      | 51.40      | 64.28       | 128.5      | 257.1     | 514.0     | 771.2     | 1 285     | 2 571   |
| 0.074 6         | 25.57      | 51.12      | 63.93       | 127.8      | 255.7     | 511.2     | 767.1     | 1 278     | 2 557   |
| 0.074 8         | 25.43      | 50.85      | 63.59       | 127.1      | 254.3     | 508.5     | 763.0     | 1 271     | 2 543   |



表 A1(续)

| 压痕对角线<br><i>d</i> /mm | 试验力/ <i>N</i> |            |             |            |           |           |           |           |         |
|-----------------------|---------------|------------|-------------|------------|-----------|-----------|-----------|-----------|---------|
|                       | 0.098 07      | 0.196 1    | 0.245 2     | 0.490 3    | 0.980 7   | 1.961 2   | 2.942 0   | 4.903     | 9.807   |
|                       | 努氏硬度          |            |             |            |           |           |           |           |         |
|                       | HK<br>0.01    | HK<br>0.02 | HK<br>0.025 | HK<br>0.05 | HK<br>0.1 | HK<br>0.2 | HK<br>0.3 | HK<br>0.5 | HK<br>1 |
| 0.075 0               | 25.30         | 50.58      | 63.25       | 126.5      | 253.0     | 505.8     | 758.9     | 1 265     | 2 530   |
| 0.075 2               | 25.16         | 50.31      | 62.92       | 125.8      | 251.6     | 503.1     | 754.9     | 1 258     | 2 516   |
| 0.075 4               | 25.03         | 50.04      | 62.58       | 125.1      | 250.3     | 500.4     | 750.9     | 1 251     | 2 503   |
| 0.075 6               | 24.90         | 49.78      | 62.25       | 124.5      | 249.0     | 497.8     | 746.9     | 1 245     | 2 490   |
| 0.075 8               | 24.77         | 49.52      | 61.93       | 123.8      | 247.7     | 495.2     | 743.0     | 1 238     | 2 477   |
| 0.076 0               | 24.64         | 49.26      | 61.60       | 123.2      | 246.4     | 492.6     | 739.1     | 1 232     | 2 464   |
| 0.076 2               | 24.51         | 49.00      | 61.28       | 122.5      | 245.1     | 490.0     | 735.2     | 1 225     | 2 451   |
| 0.076 4               | 24.38         | 48.74      | 60.96       | 121.9      | 243.8     | 487.4     | 731.4     | 1 219     | 2 438   |
| 0.076 6               | 24.25         | 48.49      | 60.64       | 121.2      | 242.5     | 484.9     | 727.6     | 1 212     | 2 425   |
| 0.076 8               | 24.13         | 48.23      | 60.32       | 120.6      | 241.3     | 482.3     | 723.8     | 1 206     | 2 413   |
| 0.077 0               | 24.00         | 47.98      | 60.01       | 120.0      | 240.0     | 479.8     | 720.0     | 1 200     | 2 400   |
| 0.077 2               | 23.88         | 47.74      | 59.70       | 119.4      | 238.8     | 477.4     | 716.3     | 1 194     | 2 388   |
| 0.077 4               | 23.75         | 47.49      | 59.39       | 118.7      | 237.5     | 474.9     | 712.6     | 1 187     | 2 375   |
| 0.077 6               | 23.63         | 47.25      | 59.09       | 118.1      | 236.3     | 472.5     | 708.9     | 1 181     | 2 363   |
| 0.077 8               | 23.51         | 47.00      | 58.78       | 117.5      | 235.1     | 470.0     | 705.3     | 1 175     | 2 351   |
| 0.078 0               | 23.39         | 46.76      | 58.48       | 116.0      | 233.9     | 467.6     | 701.7     | 1 169     | 2 339   |
| 0.078 2               | 23.27         | 46.52      | 58.18       | 116.3      | 232.7     | 465.2     | 698.1     | 1 163     | 2 327   |
| 0.078 4               | 23.15         | 46.29      | 57.89       | 115.7      | 231.5     | 462.9     | 694.5     | 1 157     | 2 315   |
| 0.078 6               | 23.03         | 46.05      | 57.59       | 115.2      | 230.3     | 460.5     | 691.0     | 1 152     | 2 303   |
| 0.078 8               | 22.92         | 45.82      | 57.30       | 114.6      | 229.2     | 458.2     | 687.5     | 1 146     | 2 292   |
| 0.079 0               | 22.80         | 45.59      | 57.01       | 114.0      | 228.0     | 455.9     | 684.0     | 1 140     | 2 280   |
| 0.079 2               | 22.69         | 45.36      | 56.72       | 113.4      | 226.9     | 453.6     | 680.6     | 1 134     | 2 269   |
| 0.079 4               | 22.57         | 45.13      | 56.44       | 112.8      | 225.7     | 451.3     | 677.2     | 1 128     | 2 257   |
| 0.079 6               | 22.46         | 44.90      | 56.15       | 112.3      | 224.6     | 449.0     | 673.8     | 1 123     | 2 246   |
| 0.079 8               | 22.35         | 44.68      | 55.87       | 111.7      | 223.5     | 446.8     | 670.4     | 1 117     | 2 235   |
| 0.080 0               | 22.23         | 44.45      | 55.59       | 111.2      | 222.3     | 444.5     | 667.0     | 1 112     | 2 223   |
| 0.080 2               | 22.12         | 44.23      | 55.32       | 110.6      | 221.2     | 442.3     | 663.7     | 1 106     | 2 212   |
| 0.080 4               | 22.01         | 44.01      | 55.04       | 110.1      | 220.1     | 440.1     | 660.4     | 1 101     | 2 201   |
| 0.080 6               | 21.90         | 43.79      | 54.77       | 109.5      | 219.0     | 437.9     | 657.1     | 1 095     | 2 190   |
| 0.080 8               | 21.80         | 43.58      | 54.50       | 109.0      | 218.0     | 435.8     | 653.9     | 1 090     | 2 180   |
| 0.081 0               | 21.69         | 43.36      | 54.23       | 108.4      | 216.9     | 433.6     | 650.7     | 1 084     | 2 169   |
| 0.081 2               | 21.58         | 43.15      | 53.96       | 107.9      | 215.8     | 431.5     | 647.5     | 1 079     | 2 158   |
| 0.081 4               | 21.48         | 42.94      | 53.70       | 107.4      | 214.8     | 429.4     | 644.3     | 1 074     | 2 148   |
| 0.081 6               | 21.37         | 42.73      | 53.43       | 106.8      | 213.7     | 427.3     | 641.1     | 1 068     | 2 137   |
| 0.081 8               | 21.27         | 42.52      | 53.17       | 106.3      | 212.7     | 425.2     | 638.0     | 1 063     | 2 127   |
| 0.082 0               | 21.16         | 42.31      | 52.91       | 105.8      | 211.6     | 423.1     | 634.9     | 1 058     | 2 116   |
| 0.082 2               | 21.06         | 42.11      | 52.66       | 105.3      | 210.6     | 421.1     | 631.8     | 1 053     | 2 106   |
| 0.082 4               | 20.96         | 41.90      | 52.40       | 104.8      | 209.6     | 419.0     | 628.7     | 1 048     | 2 096   |
| 0.082 6               | 20.86         | 41.70      | 52.15       | 104.3      | 208.6     | 417.0     | 625.7     | 1 043     | 2 086   |
| 0.082 8               | 20.76         | 41.50      | 51.90       | 103.8      | 207.6     | 415.0     | 622.7     | 1 038     | 2 076   |

表 A1(续)

| 压痕对角线<br>$d/mm$ | 试验力/N      |            |             |            |           |           |           |           |         |
|-----------------|------------|------------|-------------|------------|-----------|-----------|-----------|-----------|---------|
|                 | 0.098 07   | 0.196 1    | 0.245 2     | 0.490 3    | 0.980 7   | 1.961 2   | 2.942 0   | 4.903     | 9.807   |
|                 | 努氏硬度       |            |             |            |           |           |           |           |         |
|                 | HK<br>0.01 | HK<br>0.02 | HK<br>0.025 | HK<br>0.05 | HK<br>0.1 | HK<br>0.2 | HK<br>0.3 | HK<br>0.5 | HK<br>1 |
| 0.083 0         | 20.66      | 41.30      | 51.65       | 103.3      | 206.6     | 413.0     | 619.7     | 1 033     | 2 066   |
| 0.083 2         | 20.56      | 41.10      | 51.40       | 102.8      | 205.6     | 411.0     | 616.7     | 1 028     | 2 056   |
| 0.083 4         | 20.46      | 40.90      | 51.15       | 102.3      | 204.6     | 409.0     | 613.8     | 1 023     | 2 046   |
| 0.083 6         | 20.36      | 40.71      | 50.91       | 101.8      | 203.6     | 407.1     | 610.8     | 1 018     | 2 036   |
| 0.083 8         | 20.26      | 40.51      | 50.67       | 101.3      | 202.6     | 405.1     | 607.9     | 1 013     | 2 026   |
| 0.084 0         | 20.17      | 40.32      | 50.43       | 100.8      | 201.7     | 403.2     | 605.0     | 1 008     | 2 017   |
| 0.084 2         | 20.07      | 40.13      | 50.19       | 100.3      | 200.7     | 401.3     | 602.1     | 1 003     | 2 007   |
| 0.084 4         | 19.98      | 39.94      | 49.95       | 99.87      | 199.8     | 399.4     | 599.3     | 998.7     | 1 998   |
| 0.084 6         | 19.88      | 39.75      | 49.71       | 99.40      | 198.8     | 397.5     | 596.5     | 994.0     | 1 988   |
| 0.084 8         | 19.79      | 39.56      | 49.48       | 98.93      | 197.9     | 395.6     | 593.7     | 989.3     | 1 979   |
| 0.085 0         | 19.70      | 39.38      | 49.25       | 98.46      | 197.0     | 393.8     | 590.9     | 984.6     | 1 970   |
| 0.085 2         | 19.60      | 39.19      | 49.01       | 98.00      | 196.0     | 391.9     | 588.1     | 980.0     | 1 960   |
| 0.085 4         | 19.51      | 39.01      | 48.79       | 97.54      | 195.1     | 390.1     | 585.3     | 975.4     | 1 951   |
| 0.085 6         | 19.42      | 38.83      | 48.56       | 97.09      | 194.2     | 388.3     | 582.6     | 970.9     | 1 942   |
| 0.085 8         | 19.33      | 38.65      | 48.33       | 96.64      | 193.3     | 386.5     | 579.9     | 966.4     | 1 933   |
| 0.086 0         | 19.24      | 38.47      | 48.11       | 96.19      | 192.4     | 384.7     | 577.2     | 961.9     | 1 924   |
| 0.086 2         | 19.15      | 38.29      | 47.88       | 95.74      | 191.5     | 382.9     | 574.5     | 957.4     | 1 915   |
| 0.086 4         | 19.06      | 38.11      | 47.66       | 95.30      | 190.6     | 381.1     | 571.9     | 953.0     | 1 906   |
| 0.086 6         | 18.97      | 37.94      | 47.44       | 94.86      | 189.7     | 379.4     | 569.2     | 948.6     | 1 897   |
| 0.086 8         | 18.89      | 37.76      | 47.22       | 94.42      | 188.9     | 377.6     | 566.6     | 944.2     | 1 889   |
| 0.087 0         | 18.80      | 37.59      | 47.01       | 93.99      | 188.0     | 375.9     | 564.0     | 939.9     | 1 880   |
| 0.087 2         | 18.71      | 37.42      | 46.79       | 93.56      | 187.1     | 374.2     | 561.4     | 935.6     | 1 871   |
| 0.087 4         | 18.63      | 37.24      | 46.58       | 93.13      | 186.3     | 372.4     | 558.9     | 931.3     | 1 863   |
| 0.087 6         | 18.54      | 37.07      | 46.37       | 92.71      | 185.4     | 370.7     | 556.3     | 927.1     | 1 854   |
| 0.087 8         | 18.46      | 36.91      | 46.15       | 92.28      | 184.6     | 369.1     | 553.8     | 922.8     | 1 846   |
| 0.088 0         | 18.38      | 36.74      | 45.95       | 91.86      | 183.8     | 367.4     | 551.3     | 918.6     | 1 838   |
| 0.088 2         | 18.29      | 36.57      | 45.74       | 91.45      | 182.9     | 365.7     | 548.8     | 914.5     | 1 829   |
| 0.088 4         | 18.21      | 36.41      | 45.53       | 91.04      | 182.1     | 364.1     | 546.3     | 910.4     | 1 821   |
| 0.088 6         | 18.13      | 36.24      | 45.33       | 90.62      | 181.3     | 362.4     | 543.8     | 906.2     | 1 813   |
| 0.088 8         | 18.05      | 36.08      | 45.12       | 90.22      | 180.5     | 360.8     | 541.4     | 902.2     | 1 805   |
| 0.089 0         | 17.96      | 35.92      | 44.92       | 89.81      | 179.6     | 359.2     | 538.9     | 898.1     | 1 796   |
| 0.089 2         | 17.88      | 35.76      | 44.72       | 89.41      | 178.8     | 357.6     | 536.5     | 894.1     | 1 788   |
| 0.089 4         | 17.80      | 35.60      | 44.52       | 89.01      | 178.0     | 356.0     | 534.1     | 890.1     | 1 780   |
| 0.089 6         | 17.73      | 35.44      | 44.32       | 88.61      | 177.3     | 354.4     | 531.8     | 886.1     | 1 773   |
| 0.089 8         | 17.65      | 35.28      | 44.12       | 88.22      | 176.5     | 352.8     | 529.4     | 882.2     | 1 765   |
| 0.090 0         | 17.57      | 35.12      | 43.93       | 87.83      | 175.7     | 351.2     | 527.0     | 878.3     | 1 757   |
| 0.090 2         | 17.49      | 34.97      | 43.73       | 87.44      | 174.9     | 349.7     | 524.7     | 874.4     | 1 749   |
| 0.090 4         | 17.41      | 34.81      | 43.54       | 87.05      | 174.1     | 348.1     | 522.4     | 870.5     | 1 741   |
| 0.090 6         | 17.34      | 34.66      | 43.35       | 86.67      | 173.4     | 346.6     | 520.1     | 866.7     | 1 734   |
| 0.090 8         | 17.26      | 34.51      | 43.16       | 86.29      | 172.6     | 345.1     | 517.8     | 862.9     | 1 726   |



表 A1(续)

| 压痕对角线<br>d/mm | 试验力/N      |            |             |            |           |           |           |           |         |
|---------------|------------|------------|-------------|------------|-----------|-----------|-----------|-----------|---------|
|               | 0.098 07   | 0.196 1    | 0.245 2     | 0.490 3    | 0.980 7   | 1.961 2   | 2.942 0   | 4.903     | 9.807   |
|               | 努氏硬度       |            |             |            |           |           |           |           |         |
|               | HK<br>0.01 | HK<br>0.02 | HK<br>0.025 | HK<br>0.05 | HK<br>0.1 | HK<br>0.2 | HK<br>0.3 | HK<br>0.5 | HK<br>1 |
| 0.091 0       | 17.18      | 34.36      | 42.97       | 85.91      | 171.8     | 343.6     | 515.5     | 859.1     | 1 718   |
| 0.091 2       | 17.11      | 34.21      | 42.78       | 85.53      | 171.1     | 342.1     | 513.3     | 855.3     | 1 711   |
| 0.091 4       | 17.03      | 34.06      | 42.59       | 85.16      | 170.3     | 340.6     | 511.0     | 851.6     | 1 703   |
| 0.091 6       | 16.96      | 33.91      | 42.40       | 84.79      | 169.6     | 339.1     | 508.8     | 847.9     | 1 696   |
| 0.091 8       | 16.89      | 33.76      | 42.22       | 84.42      | 168.9     | 337.6     | 506.6     | 844.2     | 1 689   |
| 0.092 0       | 16.81      | 33.61      | 42.04       | 84.05      | 168.1     | 336.1     | 504.4     | 840.5     | 1 681   |
| 0.092 2       | 16.74      | 33.47      | 41.85       | 83.69      | 167.4     | 334.7     | 502.2     | 836.9     | 1 674   |
| 0.092 4       | 16.67      | 33.32      | 41.67       | 83.32      | 166.7     | 333.2     | 500.0     | 833.2     | 1 667   |
| 0.092 6       | 16.60      | 33.18      | 41.49       | 82.96      | 166.0     | 331.8     | 497.9     | 829.6     | 1 660   |
| 0.092 8       | 16.52      | 33.04      | 41.32       | 82.61      | 165.2     | 330.4     | 495.7     | 826.1     | 1 652   |
| 0.093 0       | 16.45      | 32.89      | 41.14       | 82.25      | 164.5     | 328.9     | 493.6     | 822.5     | 1 645   |
| 0.093 2       | 16.38      | 32.75      | 40.96       | 81.90      | 163.8     | 327.5     | 491.5     | 819.0     | 1 638   |
| 0.093 4       | 16.31      | 32.61      | 40.79       | 81.55      | 163.1     | 326.1     | 489.4     | 815.5     | 1 631   |
| 0.093 6       | 16.24      | 32.47      | 40.61       | 81.20      | 162.4     | 324.7     | 487.3     | 812.0     | 1 624   |
| 0.093 8       | 16.17      | 32.34      | 40.44       | 80.86      | 161.7     | 323.4     | 485.2     | 808.6     | 1 617   |
| 0.094 0       | 16.10      | 32.20      | 40.27       | 80.51      | 161.0     | 322.0     | 483.1     | 805.1     | 1 610   |
| 0.094 2       | 16.04      | 32.06      | 40.10       | 80.17      | 160.4     | 320.6     | 481.1     | 801.7     | 1 604   |
| 0.094 4       | 15.97      | 31.93      | 39.93       | 79.83      | 159.7     | 319.3     | 479.1     | 798.3     | 1 597   |
| 0.094 6       | 15.90      | 31.79      | 39.76       | 79.49      | 159.0     | 317.9     | 477.0     | 794.9     | 1 590   |
| 0.094 8       | 15.83      | 31.66      | 39.59       | 79.16      | 158.3     | 316.6     | 475.0     | 791.6     | 1 583   |
| 0.095 0       | 15.77      | 31.52      | 39.42       | 78.83      | 157.7     | 315.2     | 473.0     | 788.3     | 1 577   |
| 0.095 2       | 15.70      | 31.39      | 39.26       | 78.49      | 157.0     | 313.9     | 471.0     | 784.9     | 1 570   |
| 0.095 4       | 15.64      | 31.26      | 39.09       | 78.17      | 156.4     | 312.6     | 469.1     | 781.7     | 1 564   |
| 0.095 6       | 15.57      | 31.13      | 38.93       | 77.84      | 155.7     | 311.3     | 467.1     | 778.4     | 1 557   |
| 0.095 8       | 15.51      | 31.00      | 38.77       | 77.51      | 155.1     | 310.0     | 465.2     | 775.1     | 1 551   |
| 0.096 0       | 15.44      | 30.87      | 38.61       | 77.19      | 154.4     | 308.7     | 463.2     | 771.9     | 1 544   |
| 0.096 2       | 15.38      | 30.74      | 38.45       | 76.87      | 153.8     | 307.4     | 461.3     | 768.7     | 1 538   |
| 0.096 4       | 15.31      | 30.61      | 38.29       | 76.55      | 153.1     | 306.1     | 459.4     | 765.5     | 1 531   |
| 0.096 6       | 15.25      | 30.49      | 38.13       | 76.24      | 152.5     | 304.9     | 457.5     | 762.4     | 1 525   |
| 0.096 8       | 15.19      | 30.36      | 37.97       | 75.92      | 151.9     | 303.6     | 455.6     | 759.2     | 1 519   |
| 0.097 0       | 15.12      | 30.24      | 37.81       | 75.61      | 151.2     | 302.4     | 453.7     | 756.1     | 1 512   |
| 0.097 2       | 15.06      | 30.11      | 37.66       | 75.30      | 150.6     | 301.1     | 451.8     | 753.0     | 1 506   |
| 0.097 4       | 15.00      | 29.99      | 37.50       | 74.99      | 150.0     | 299.9     | 450.0     | 749.9     | 1 500   |
| 0.097 6       | 14.94      | 29.87      | 37.35       | 74.68      | 149.4     | 298.7     | 448.2     | 746.8     | 1 494   |
| 0.097 8       | 14.88      | 29.74      | 37.20       | 74.38      | 148.8     | 297.4     | 446.3     | 743.8     | 1 488   |
| 0.098 0       | 14.82      | 29.62      | 37.05       | 74.07      | 148.2     | 296.2     | 444.5     | 740.7     | 1 482   |
| 0.098 2       | 14.76      | 29.50      | 36.90       | 73.77      | 147.6     | 295.0     | 442.7     | 737.7     | 1 476   |
| 0.098 4       | 14.70      | 29.38      | 36.75       | 73.47      | 147.0     | 293.8     | 440.9     | 734.7     | 1 470   |
| 0.098 6       | 14.64      | 29.26      | 36.60       | 73.17      | 146.4     | 292.6     | 439.1     | 731.7     | 1 464   |
| 0.098 8       | 14.58      | 29.15      | 36.45       | 72.88      | 145.8     | 291.5     | 437.3     | 728.8     | 1 458   |