

ICS 29.045
CCS H 83



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 43662-2024

Patterned sapphire substrate

蓝宝石图形化衬底片

Issued on: March 15, 2024

Implemented on: October 1, 2024

**Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC**

Table of Contents

- 1 Scope
- 2 Normative references
- 3 Terms and definitions
- 4 Classification
- 5 Technical requirements
- 6 Test methods

1 Scope

The document specifies the technical requirements, test methods, inspection rules, marking, packing, transport, storage, accompanying documents and order form content of patterned sapphire substrates, called substrates in the rest of the text.

It applies to the research and development, production, testing, inspection and quality performance evaluation of patterned sapphire substrates.

2 Normative references

The content of the documents listed below constitutes indispensable provisions of this document through normative reference in the text. For dated references, only the edition corresponding to that date applies; for undated references, the latest edition, including all amendments, applies.

GB/T 2828.1-2012 Sampling procedures for inspection by attributes - Part 1: Sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection; GB/T 8758 Method for measurement of gallium arsenide epitaxial layer thickness by infrared interference; GB/T 14140 Method for measurement of silicon wafer diameter; GB/T 14264 Terminology of semiconductor materials; GB/T 20307 General rules for scanning electron microscope measurement of nanoscale length; GB/T 25915.1-2021 Cleanrooms and associated controlled environments - Part 1: Classification of air cleanliness by particle concentration.

3 Terms and definitions

The terms and definitions given in GB/T 14264 and the following apply to this document.

3.1 patterned substrate: substrate whose surface carries a periodic array of micro-nano pattern structures shaped as cone-like bodies, produced by a photolithographic or imprint pattern mask process followed by plasma etching. Note: the patterned substrate is used to

improve the photoelectric performance of gallium nitride light emitting diodes.

3.2 pattern arrangement: array distribution in position and direction of the patterns on the substrate surface, following the closest packing principle. The 0 degree arrangement is shown in Figure 1 of the document and the 90 degree arrangement in Figure 2.

3.3 pattern bottom: position at which the pattern on the substrate surface meets the area without pattern.

3.4 pattern pitch, P: distance between the geometric centre points of any two adjacent patterns in the repeated arrangement of identical patterns on the substrate surface.

3.5 pattern height, H: vertical distance from the plane of the pattern bottom to the apex of the pattern.

3.6 pattern bottom width, W: largest width of the pattern area on the plane of the pattern bottom area.

3.7 pattern space, S: shortest distance between the edges of any two adjacent patterns on the plane of the pattern bottom area.

3.8 pattern bottom angle, theta: angle between the plane of the pattern bottom and the side wall of the pattern.

3.9 pattern arc spacing, R: largest perpendicular distance from the pattern side wall to the line joining the bottom end point of the side wall and the apex. The Chinese heading printed for this entry is the same as the one printed for 3.7; see the note at the end of this record.

3.10 pattern uniformity, U: degree of dispersion of the pattern dimensional parameters over the patterned substrate.

3.11 pin: trace of the fixing jig used on the edge circumference of the patterned substrate to keep the wafer stable during etching.

3.12 pattern loss: phenomenon in which the periodically arrayed patterns are absent or destroyed in a local area of the patterned substrate.

3.13 grid line: phenomenon in which the appearance shows a grid, caused by the stitching of the reticle when the patterned substrate is prepared with a step-and-repeat projection lithography machine.

3.14 mis-alignment: phenomenon in which patterns are incompletely joined or displaced when the patterned substrate is prepared with a step-and-repeat projection lithography machine.

4 Classification

4.1 By diameter the substrate is divided into four sizes: 50.8 mm (2 in), 100 mm (4 in), 150 mm (6 in) and 200 mm (8 in).

4.2 By guide edge the substrate is divided into the reference flat guide edge, shown in Figure 9 of the document, and the reference notch guide edge, shown in Figure 10.

5 Technical requirements

5.1 Substrate dimensions shall conform to Table 1. The table has four columns, one per size. Diameter and its permissible deviation are 50.8 mm $\pm$ 0.1 mm for the 2 in size, 100 mm $\pm$ 0.1 mm for the 4 in size, 150 mm $\pm$ 0.2 mm for the 6 in size and 200 mm $\pm$ 0.2 mm for the 8 in size. Thickness and its permissible deviation are 430 μ m $\pm$ 10 μ m for the 2 in size; 650 μ m $\pm$ 20 μ m or 800 μ m $\pm$ 20 μ m for the 4 in size; 1 000 μ m $\pm$ 20 μ m or 1 300 μ m $\pm$ 20 μ m for the 6 in size; 1 300 μ m $\pm$ 20 μ m or 1 600 μ m $\pm$ 20 μ m for the 8 in size.

5.2.1 Substrate pattern dimensions shall conform to Table 2. Each item of the table carries two alternative specification sets. Pattern pitch: 3.0 μ m $\pm$ 0.1 μ m or 1.8 μ m $\pm$ 0.1 μ m. Pattern height: 1.80 μ m $\pm$ 0.2 μ m or 0.9 μ m $\pm$ 0.1 μ m. Pattern bottom width: 2.80 μ m $\pm$ 0.2 μ m or 1.6 μ m $\pm$ 0.1 μ m. The table then carries two rows printed with the same Chinese heading: the first gives 0.20 μ m $\pm$ 0.2 μ m or 0.2 μ m $\pm$ 0.1 μ m, the second gives 100 nm to 200 nm or 40 nm to 90 nm. Which of the two rows belongs to pattern space (3.7) and which to pattern arc spacing (3.9) is not stated in the document and is not reported here. Pattern bottom angle: 60° $\pm$ 10° or 50° $\pm$ 10°.

5.2.2 The reflectance of the substrate is evaluated through single-point reflectance, mean reflectance, standard deviation of the reflectance distribution and reflectance range, and shall conform to Table 3. The table has two columns, item and value range: single-point reflectance 0 to 255; mean reflectance 70 to 140; standard deviation of the reflectance distribution 0 to 10; reflectance range 0 to 30. The document states no unit for these quantities.

5.2.3.1 Taking the guide edge of the substrate as reference, five points are taken on the substrate, top, middle, bottom, left and right, at 5 mm from the edge, and the pattern height and the pattern bottom width are measured there; the in-wafer uniformity shall not exceed 5 %.

5.2.3.2 and 5.2.3.3 Height uniformity is calculated by formula (1) and bottom width uniformity by formula (2). In formula (1) U_h is the substrate height uniformity, $H_{\max}$ the largest value of pattern height and $H_{\min}$ the smallest value of pattern height. In formula (2) U_w is the substrate bottom width uniformity, $W_{\max}$ the largest value of pattern bottom width and $W_{\min}$ the smallest value of pattern bottom width.

5.2.4 The width of the ring-shaped area without pattern at the substrate edge, marked A in Figure 11, shall be less than 0.5 mm; the distance over which the pin of the substrate extends from the edge into the wafer, marked B, shall be less than 0.9 mm; the width of the ring-shaped area between the qualified quality zone of the substrate and the substrate

edge, marked C, shall be less than 1.5 mm.

5.3 The appearance of the substrate shall conform to Annex A.

5.4 Where the purchaser has other requirements for the substrate, these are agreed between supplier and purchaser.

6 Test methods

6.1.1 The substrate diameter and its permissible deviation are tested according to GB/T 14140.

6.1.2 The substrate thickness and its permissible deviation are tested according to GB/T 8758.

6.2 The substrate pattern dimensions are tested according to Annex B, the substrate reflectance according to Annex C, the substrate uniformity according to Annex D and the ineffective pattern area of the substrate according to Annex E.

6.3.1 Macroscopic inspection of the substrate appearance is carried out by eye under an illuminance of (350 ± 50) lx, a colour temperature of $(5\,000 \pm 1\,000)$ K and a viewing distance of (300 ± 50) mm; where the visual inspection finds a defect, a metallographic microscope is used to measure and judge it.

6.3.2 Microscopic inspection of the substrate appearance is carried out according to Annex C.

Note Notes on the original text

The same Chinese heading is printed for two different terms, 3.7, glossed pattern space with symbol S, and 3.9, glossed pattern arc spacing with symbol R; the two English glosses differ, the Chinese headings do not. The same duplication is reproduced in Table 2, which carries two rows with that identical heading.

In Table 2 the first of those two rows gives a value of $0.20\ \mu\text{m}$ with a permissible deviation of $\pm 0.2\ \mu\text{m}$, that is a deviation as large as the value itself. The figure is reported here as printed.

Clause 5.3 refers the substrate appearance to Annex A, while 6.3.2 refers the microscopic inspection of the appearance to Annex C, the same annex to which 6.2.2 refers the reflectance test. The annexes are not part of the pages available, so the point is only recorded, not resolved.