

SEMI HB9-0818

TEST METHOD AND ACCEPTANCE CRITERIA FOR VISUAL INSPECTION OF SURFACE DEFECTS OF GAN EPITAXIAL WAFERS USED FOR MANUFACTURING HB-LED

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NOTICE: This Standard or Safety Guideline has an Inactive Status because the conditions to maintain Current Status have not been met. Inactive Standards or Safety Guidelines are available from SEMI and continue to be valid for use.

1 Purpose

1.1 The purpose of this Standard is to provide test methods to visually detect surface defects of GaN epitaxial wafer for manufacturing high brightness LEDs, and to define acceptance criteria for the types, number, size, and distribution area.

2 Scope

2.1 This Test Method defines the equipment and measurement procedure for visually detecting the surface defects of GaN epitaxial wafer for manufacturing high brightness LEDs. The test method applies to homoepitaxial wafers on GaN bulk substrates as well as to heteroepitaxial wafers on substrates such as sapphire, silicon SiC and other materials used for manufacturing HB-LED.

2.2 This Test Method defines the surface defect characterization requirements and the acceptance criteria for GaN based LED epitaxial wafers.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Referenced Standards and Documents

3.1 None.

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

4 Terminology

4.1 Definitions

4.1.1 *black spot* — a dot like defect that appears dark at the wafer surface in visual inspection due to presence of pit, pinhole, embedded particle etc.

4.1.2 *breakage* — the separation of a wafer into two or more pieces due to wafer breaking.

4.1.3 *contamination* — the presence of extraneous material that renders a substance undesirable on the wafer surface.

4.1.4 *crack* — an opening in the wafer surface due to internal strain.

4.1.5 *defect concentrated area* — the surface area where the point and planar surface defects are concentrated.

4.1.6 *haze* — a diminished surface brightness or specularity attributable to diffuse light scattering by concentrations of microscopic surface irregularities, or to chemical inhomogeneity.

4.1.7 *hillock* — a localized protuberance of material from the wafer surface.

4.1.7.1 *Discussion* — For GaN epitaxial wafers, these are usually hexagonal.

4.1.8 *particle* — a foreign solid material attached to the wafer surface and partly buried in the epilayer.

4.1.9 *pinhole* — a hole deep through the whole epitaxial layer with exposure of substrate.

4.1.10 *pit* — a depression at the surface of wafers, typically with inverted pyramid shape for GaN LED wafer.

4.1.11 *PSS shot fail* — grid lines of epitaxial wafers formed by mismatch or gap between adjacent shots in processing patterned sapphire substrate.

4.1.12 *PSS pattern missing* — absence of at least one PSS pattern in an otherwise perfect periodic patterned sapphire substrate.

4.1.13 *quality area* — the central area of wafer surface, defined by a nominal edge exclusion, EE, over which the specified values of a parameter apply.

4.1.14 *scratch* — an elongated mark or groove cut in the surface by mechanical means, not associated with the predominant surface texture pattern.

4.1.15 *surface defect* — an irregularity, such as a crack, hillock or pit, at a wafer surface that could adversely affect device performance.

5 Summary of Test Method

5.1 Inspection Method

5.1.1 Two visual inspection methods should be performed, naked eye examination and metallographic microscope examination. For the naked eye examination, all produced wafers should be inspected. For the metallographic microscope examination, firstly one piece of wafer from every MOCVD batch should be thoroughly inspected by 'Z' shape moving the wafer at a magnification of 200. If some black spot defects are found, then all the rest wafers from the same batch should be inspected by metallographic microscope.

5.2 Visual Acceptance Criteria

5.2.1 Edge Exclusion

5.2.2 The excluded edge area should be no more than 3 mm from the round edge and no more than 7 mm from the flat edge.

5.2.3 Surface requirements for the GaN based LED wafers in this specification are shown in Table 1.

6 Apparatus

6.1 *Spotlight* — At a distance of 10 cm from the light source, the diameter of the illuminated area should be larger than 5 cm and the light intensity should be larger than 16000 lx.

6.2 Tweezers

6.3 Metallographic microscope

7 Procedure

7.1 Full Inspection by Naked Eyes

7.1.1 Pick up one wafer from the cassette by tweezers and put it under a spotlight. As shown in the Figure 1, keep the distance between the spotlight and wafer in the range of 10 to 15 cm, $\alpha = 45^\circ \pm 10^\circ$, and $\beta = 90^\circ \pm 10^\circ$.

7.1.2 Move the wafer, and identify defect types and count the number or measure the size of defects.

7.1.3 Make calculations on the ratio of defect concentrated area to the total effective wafer area.

7.1.4 Repeat above steps until finish inspecting all the wafers produced.

7.1.5 Record the inspected results.