



Test Method for Crystallographic Perfection of Gallium Arsenide by Molten Potassium Hydroxide (KOH) Etch Technique¹

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1. Scope

1.1 This test method is used to determine whether an ingot or wafer of gallium arsenide is monocrystalline and, if so, to measure the etch pit density and to judge the nature of crystal imperfections. To the extent possible, it follows the corresponding test method for silicon, Test Method F47. Test Method F47 also presents the definition of many crystallographic terms, applicable to this test method.

1.2 This procedure is suitable for gallium arsenide crystals with etch pit densities between 0 and 200 000/cm².

1.3 Gallium arsenide, either doped or undoped, and with various electrical properties, may be evaluated by this test method. The front surface normal direction of the sample must be parallel to the $\langle 001 \rangle$ within $\pm 5^\circ$ and must be suitably prepared by polishing or etching, or both. Unremoved processing damage may lead to etch pits, obscuring the quality of the bulk crystal.

1.4 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.* Specific hazard statements are given in Section 8.

2. Referenced Documents

2.1 *ASTM Standards:*²

D1125 Test Methods for Electrical Conductivity and Resistivity of Water

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

F26 Test Methods for Determining the Orientation of a

Semiconductive Single Crystal (Withdrawn 2003)³

F47 Test Method for Crystallographic Perfection of Silicon by Preferential Etch Techniques³

3. Summary of Test Method

3.1 The determination of the etch pit density is only meaningful for monocrystalline material. After a mechanical or chemical polish, or both, of the sample surface, the sample is etched in molten KOH. This agent preferentially attacks the gallium arsenide surface in regions of crystal imperfections, such as low angle grain boundaries, twin lamellae, precipitates, slip lines, and dislocations. The etched surface is examined microscopically to characterize these imperfections, and determine their density.

3.2 Viewed through an optical microscope, etch pits appear as dark elongated hexagonal pits. The etch pit density (EPD) is determined by counting these pits at nine different standardized locations across the sample along $\langle 011 \rangle$ and $\langle 001 \rangle$ directions. A lens micrometer or a grid installed in the microscope is used to define the sampling area. The reported EPD is obtained by averaging the EPD values in the nine counted areas.

3.2.1 The orientation of the elongated KOH etch pits may also be used to determine the crystal orientation prior to the addition of flats to gallium arsenide (GaAs) wafers or crystals.

4. Significance and Use

4.1 The use of GaAs for semiconductor devices requires a consistent atomic lattice structure. However, lattice or crystal line defects of various types and quantities are always present, and rarely homogeneously distributed. It is important to determine the mean value and the spatial distribution of the etch pit density.

5. Characteristics of Revealed Imperfections

5.1 The KOH etch of the specimen surface reveals patterns that are characteristic for several of the crystalline defects described in detail in Test Method F47.

5.1.1 Dislocations on $\{100\}$ GaAs surfaces are characterized by microscopic anisotropic six-sided etch pits. The size of

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.