



Designation: F 358 – 83 (Reapproved 1996)^{ε1}

Standard Test Method for Wavelength of Peak Photoluminescence and the Corresponding Composition of Gallium Arsenide Phosphide Wafers¹

This standard is issued under the fixed designation F 358; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

^{ε1} NOTE—Keywords were added editorially in February 1997.

1. Scope

1.1 This test method covers the techniques used to determine the wavelength of the photoluminescence peak and the mole percent phosphorus content of gallium arsenide phosphide, GaAs_(1-x)P_x.

1.2 Photoluminescence measurements indicate the composition only in the illuminated region and only within a very short distance from the surface, a distance limited by the penetration of the radiation and the diffusion length of the photo-generated carriers, as contrasted to X-ray measurements which sample a much deeper volume.

1.3 This test method is limited by the surface preparation procedure to application to epitaxial layers of the semiconductor grown in a vapor-phase reactor on a flat substrate. It is directly applicable to *n*-type GaAs_(1-x)P_x with the wavelength, λ_{PL} , of the photoluminescence peak in the range from 640 to 670 nm, corresponding to mole percent phosphorus in the range from 36 to 42 % ($x = 0.36$ to 0.42). The calibration data provided for the determination of x from λ_{PL} is applicable to material doped with tellurium or selenium at concentrations in the range from 10^{16} to 10^{18} atoms/cm³.

1.4 The principle of this test method is more broadly applicable. Other material preparation methods may require different surface treatments. Extension to other dopants, doping ranges or composition ranges requires further work to relate λ_{PL} to the phosphorus content as determined by X-ray measurements of the precise dimensions of the unit cell upon which the calibration data are based. It is essential that calibration specimens have uniform composition in the volume sampled.

1.5 This test method is essentially nondestructive. It requires a light etching of the sample to be measured. The removal of a layer of material approximately 0.5 to 1.0 μm in thickness is required. This etching does not degrade the specimen in that devices can still be fabricated from it.

1.6 This test method is applicable to process control in the preparation of materials and to materials acceptance.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific hazard statements are given in Section 7.

2. Referenced Documents

2.1 ASTM Standards:

D 1125 Test Methods for Electrical Conductivity and Resistivity of Water²

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods³

E 275 Practice for Describing and Measuring Performance of Ultraviolet, Visible, and Near-Infrared Spectrophotometers⁴

2.2 SEMI Standard:

C1 Specifications for Reagents⁵

3. Summary of Test Method

3.1 The photoluminescence spectrum is recorded for the wavelength range from 600 to 750 nm and the wavelength, λ_{PL} , at which maximum luminescence occurs is determined by means of a graphical construction. The phosphorus content is then determined by means of a calibration curve relating λ_{PL} to the amount of phosphorus as determined by X-ray measurement of the precise dimension of the unit cell.

4. Interferences

4.1 The apparent position of the photoluminescence peak can be distorted by the spectral response characteristics of the detection system, and, in particular, by the spectral response of the photomultiplier. Therefore, the detector to be used for measurements on a specific range of alloy compositions should be chosen so that the corresponding range of λ_{PL} falls in a region where the detector response is changing slowly.

¹ This test method is under the jurisdiction of Committee F-1 on Electronics and is the direct responsibility of Subcommittee F01.15 on Gallium Arsenide.

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² Annual Book of ASTM Standards, Vol 11.01.

³ Annual Book of ASTM Standards, Vol 14.02.

⁴ Annual Book of ASTM Standards, Vol 03.06.

⁵ Available from Semiconductor Equipment and Materials Institute, 625 Ellis St., Suite 212, Mountain View, CA 94043.