

SEMI M30-0997 (Withdrawn 0309) STANDARD TEST METHOD FOR SUBSTITUTIONAL ATOMIC CARBON CONCENTRATION IN GaAs BY FOURIER TRANSFORM INFRARED ABSORPTION SPECTROSCOPY

This Standard was technically approved by the Compound Semiconductor Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on November 19, 2008. Available at www.semi.org in March 2009; originally published in 1997.

NOTICE: This Document was balloted and approved for withdrawal in 2009.

1 Purpose

1.1 The purpose of this Document is to test substitutional atomic carbon concentration in GaAs by Fourier transform infrared absorption spectroscopy (FT-IR).

2 Scope

2.1 This referee Test Method covers the determination of substitutional carbon concentration in single crystal GaAs.

2.2 The useful range of carbon concentration measurable at room temperature by this Test Method is from the maximum amount of substitutional carbon soluble in GaAs to $1 \times 10^{15} \text{ cm}^{-3}$. The detection limit depends on the equipment and measurement conditions. It is expected that many users of this Test Method can reduce the detection limit to 10^{14} cm^{-3} level. 77K measurement is effective to reduce the detection limit. In the case of 77K measurement, the upper limit is $1.3 \times 10^{16} \text{ cm}^{-3}$, as described in the following article:

T.Arai *et al*: J. Electronic Industry, Vol. 30, 9 (1988) 38

2.3 This Test Method utilizes the relationship between carbon concentration and absorption coefficient at 580 cm^{-1} for room temperature measurement (around 582 cm^{-1} for 77K measurement), the infrared absorption band is associated with substitutional carbon in GaAs. These specific absorption bands in GaAs have been associated with the local vibration mode of C_{as} .

2.4 The method is applicable to Semi-Insulating (SI) GaAs. Slices can be any crystallographic orientation and should be polished or lapped and etched on both surfaces.

2.5 This Test Method is intended to be used with FT-IR spectrometers that are equipped to operate in the region including the wave number range from 700 to 500 cm^{-1} .

2.6 This Standard may involve hazardous materials, operation, and equipment.

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 ASTM Standards¹

ASTM E131 — Definitions of Terms and Symbols Relating to Molecular Spectroscopy

ASTM E168 — Recommended Practices for General Techniques of Infrared Quantitative Analysis

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

ASTM E120 — Practice for Infrared Absorption Analysis of Impurities in Single Crystal Semiconductor Materials

ASTM F133 (A894) — Test Method for Thickness and Thickness Variation of GaAs Slices

¹ ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA; Telephone: +1.610.832.9585, Fax: +1.610.832.9555, <http://www.astm.org>

3.2 Other Document

DIN 50449-1 — Determination of Impurity Content in Semiconductors by Infrared Absorption Part 1: Carbon in Gallium Arsenide²

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

4 Terminology

4.1 Abbreviations and Acronyms

4.1.1 *CPAA* — charged particle activation analysis

4.1.2 *FWHM* — full width at half maximum; the width of the absorption band at half its magnitude as measured from the baseline.

4.1.3 *MCT* — mercury cadmium telluride

4.1.4 *TGS* — triglycine sulfate

4.2 Many of the terms associated with this Test Method can be found in ASTM E131.

4.2.1 *baseline* — a linearly interpolated pattern over a limited spectral region of the ratio recording used to derive an absorption coefficient (see Figure 1 and refer to ASTM E168).

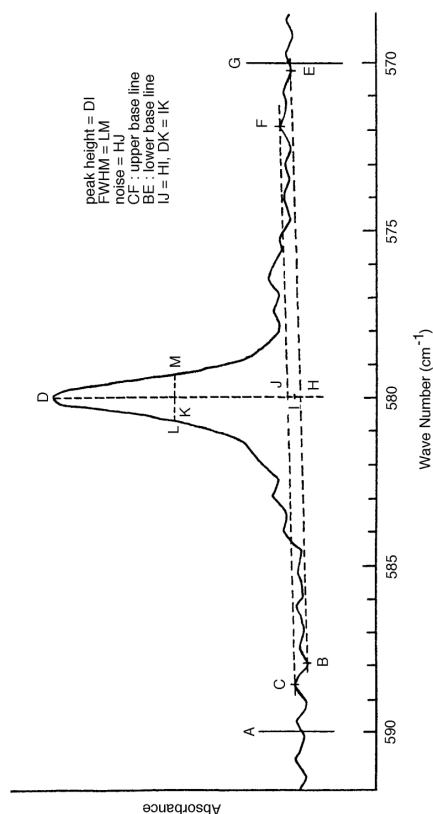


Figure 1
FT-IR Spectrum of C_{as} Local Mode Absorption in GaAs

² Deutsches Institut für Normung e.V., Available from Beuth Verlag GmbH, Burggrafenstrasse 4-10, D-10787 Berlin, Germany;
<http://www.din.de>