

SEMI M44-0301^E

GUIDE TO CONVERSION FACTORS FOR INTERSTITIAL OXYGEN IN SILICON

This guide was technically approved by the Global Silicon Wafer Committee and is the direct responsibility of the North American Silicon Wafer Committee. Current edition approved by the North American Regional Standards Committee on November 22, 2000. Initially available at www.semi.org December 2000; to be published March 2001.

^E This document was editorially modified in May 2001 to reflect the creation of JEITA via the merger of JEIDA and EIAJ. Changes were made to Section 3.4 and the associated footnote.

1 Purpose

1.1 This guide is a compilation of the conversion and calibration factors used by different Standards established for the measurement of interstitial oxygen in silicon.

2 Scope

2.1 This guide allows the user of the guide to convert quantitative values obtained from one Standard to another.

2.2 This guide does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this guide to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3 Referenced Standards

NOTE 1: As listed or revised, all documents cited shall be the latest publications of adopted standards.

3.1 SEMI Standards

SEMI M1 — Specifications for Polished Monocrystalline Silicon Wafer

SEMI M11 — Specifications for Silicon Epitaxial Wafers for Advanced Applications

3.2 ASTM Standards¹

F121-79 — Test Method for Interstitial Atomic Oxygen Content of Silicon by Infrared Absorption

F121-83 — Test Method for Interstitial Atomic Oxygen Content of Silicon by Infrared Absorption

F1188-93a — Test Method for Interstitial Atomic Oxygen Content of Silicon by Infrared Absorption

F1241-95 — Standard Terminology of Silicon Technology

F1366-92 — Test Method for Measuring Oxygen Concentration in Heavily Doped Silicon Substrates by Secondary Ion Mass Spectrometry.

3.3 DIN Standard²

DIN 50438/1 — Determination of Impurity Content in Silicon by Infrared Absorption: Oxygen

3.4 JEITA Standard³

JEIDA 61-2000 — Standard Test Method for Atomic Oxygen Content of Silicon by Infrared Absorption (refers to IOC-88)⁴

3.5 Other

Report 1982⁵ Determination of Conversion Factor for Infrared Measurement of Oxygen in Silicon

4 Terminology

4.1 Many terms relating to silicon technology are defined in ASTM Terminology F 1241.

5 Other Techniques

5.1 Other measurement techniques for measuring oxygen in silicon (e.g., SIMS or GFA) measure total oxygen whereas the referenced methods measure interstitial oxygen only. For details, refer to ASTM Test Methods.¹

6 Conversion Factors Among International Standards

6.1 Table 1 gives the conversion factors to convert oxygen concentration of one standard to oxygen concentration of another standard.

1 ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

2 Deutsches Institut für Normung e.V. Beuth Verlag GmbH Burggrafenstrasse 4-10 D-10787 Berlin, Germany

3 Japan Electronics and Information Technology Industries Association, 3rd Floor Mitsui Kaijo Bldg. Annex 11, Kanda Surugadai 3-chome, Chiyoda-ku, Tokyo 101-0062, Japan

4 Refer to ASTM F1188-93a.

5 Published in J. Electrochem. Soc., Vol.132, P.1707-1713, (1985)

6.2 Table 2 gives the calibration factors, in ppma and atoms/cm³, for absorption coefficient to interstitial oxygen for different standards.

6.3 Irrespective of a standard, the conversion of concentration (atoms/cm³) to ppma, within the same Standard, is done by dividing the value by,

$$5 \times 10^{16} \text{ (atoms per cm}^3 \text{ / ppma),} \quad (1)$$

and conversion of ppma to concentration (atoms/cm³), within the same Standard is done by multiplying the value by (1).

Table 1 Conversion Factors

<i>To Convert from</i>	<i>TO ASTM F121-79 (Old)</i>	<i>TO ASTM F121-83 (New)</i>	<i>TO ASTM F1188-93a (IOC-88) or DIN</i>	<i>JEIDA⁵</i>
ASTM F121-79 (Old)	1	0.509	0.652	0.633
ASTM F121-83 (New)	1.965	1	1.282	1.245
ASTM F1188-93 (IOC-88) or DIN	1.533	0.780	1	0.971
JEIDA ⁵	1.579	0.803	1.030	1

Table 2 Calibration Factors

<i>Calibration Factor</i>	<i>Value to Obtain Oxygen Content in ppma</i>	<i>Value to Obtain Oxygen Content in atoms/cm³</i>
ASTM F121-79 (Old)	9.63	4.815×10^{17}
ASTM F121-83 (New)	4.90	2.45×10^{17}
ASTM F1188-93 (IOC-88) or DIN	6.28	3.14×10^{17}
JEIDA ⁵	6.10	3.05×10^{17}

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