

SEMI C66-0308

GUIDELINES FOR TRIMETHYLALUMINIUM (TMAI), 99.5% QUALITY

This Standard was technically approved by the Liquid Chemicals Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on December 20, 2007. Available at www.semi.org in February 2008.

1 Purpose

1.1 The purpose of this Document is to provide guidelines for trimethylaluminium (TMAI) used in the semiconductor industry.

2 Scope

2.1 The scope of this Document covers high purity trimethylaluminium (TMAI) which is used in the semiconductor industry for the deposition of aluminium metal by vapour deposition techniques and aluminium oxide based layers by atomic layer deposition.

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 *SEMI Standards and Safety Guidelines*

SEMI C1 — Guide for the Analysis of Liquid Chemicals

3.2 *ASTM Standard*¹

ASTM D5127 — Standard Guide for Ultra Pure Water Used in the Electronics and Semiconductor Industry

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

4 Terminology

4.1 *Abbreviations and Acronyms*

4.1.1 *TMAI* — Trimethylaluminium

5 Physical Properties (for information only)

Molecular Formula	Al(CH ₃) ₃
CAS Number	75-24-1
Molecular weight (g/mol)	72.09
Boiling point at 760 mm Hg	(261°F) 127°C
Vapour pressure (P=mmHg, T=K)	log ₁₀ P = 8.22-2134/T
Freezing point	(60°F) 15°C
Liquid density at 20°C	0.752g/mL
Solubility in water	Reacts violently
Appearance	Pyrophoric colourless liquid

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>

6 Requirements

6.1 The requirements for trimethylaluminium (TMAI) for Tier A are listed in Table 1.

7 Grade 1 Procedures

7.1 This section does not apply to this chemical.

8 Grade 2 Procedures

8.1 This section does not apply to this chemical.

9 Grade 3 Procedures

9.1 This section does not apply to this chemical.

10 Grade 4 Procedures

10.1 This section does not apply to this chemical.

11 Tier A Procedures

NOTE 1: Standardized test methods are being developed for all parameters at the purity level indicated. Until standardized test methods are published, test methodology shall be determined by user and producer.

11.1 *Trace Metals Analysis* — The following method has given satisfactory results in determining trace metal impurities at the specified value for the elements listed in Table 1. Alternate methods may be used as long as validation according to SEMI C1 is demonstrated.

11.1.1 *Special Reagents* — All water used in the *trace metals analysis* should be de-ionized water meeting the criteria for Type E1.1 in ASTM D5127.

11.1.2 *Mixed Acid* — 1% HF – 2% HNO₃ prepared by dilution of ultra pure acids with appropriate weights of deionized water.

11.1.3 *Standards* — Composite standard solutions containing 0, 1, 2, and 4 ppb multi-element standards are prepared by diluting with mixed acid of appropriate weights for inductively coupled plasma mass spectrometry (ICP-MS). Single-element standard (Si) is prepared for inductively couple plasma optical emission spectrometry (ICP-OES).

11.1.4 *Sample Preparation* — In a clean environment, place 10 g of sample in a clean PFA Teflon closed bottle equipped with an inlet and outlet tube and evaporate under a nitrogen purge at 25°C. When dry, close the inlet and the outlet tube and digest the residue at 100°C for 30 minutes with 5 mL of mixed acid solution. Cool and transfer the contents with deionized water. Dilute the transferred contents with de-ionized water to a final volume of 25 mL.

11.1.5 *Analysis* — Analyze the samples by ICP-OES for silicon (Si) and phosphorous (P). Phosphorus can also be analysed for by high resolution ICP-MS. Analyze the sample for all other metallic elements by ICP-MS.

11.2 *Oxygen Analysis* — The following method has given satisfactory results in determining oxygen level at the specified value using 1H FTNMR. Note oxygen is not present in gaseous form as it reacts with TMAI forming dimethylaluminium monomethoxide. The oxygen concentration is determined from the alkoxide (OMe) peak which is referenced to a suitable internal reference standard.

11.2.1 *Sample Preparation* — Under an inert atmosphere transfer 0.2ml of TMAI into an NMR tube. Add 1 mL of a solution of the internal standard in deuterated benzene.

11.2.2 *Analysis* — Calculate oxygen from the integration of the alkoxide peak with reference to that of the internal standard.

11.3 *Hydrocarbons Analysis* — The following method has given satisfactory results in determining total hydrocarbons at the specified value using 1H FTNMR.

11.3.1 *Sample Preparation* — The sample as prepared under ¶ 11.2.1 above may be used.

11.3.2 *Analysis* — Calculate hydrocarbons from the integrations of peaks in the hydrocarbon region with that of the internal standard. For convenience hydrocarbons may be calculated as hexane.