

SEMI E45-95 (Reapproved 1000)

TEST METHOD FOR THE DETERMINATION OF INORGANIC CONTAMINATION FROM MINIENVIRONMENTS

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This document was editorially modified to match current guidelines. Changes were made to Sections 3.2, 4, and 8.1.1.

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1 Purpose

1.1 This test method provides the analytical procedures to determine the level of inorganic contamination from a minienvironment.

2 Scope

2.1 This document relates to inorganic impurities, which includes metallic contaminants, whether they occur as atoms, molecules, or particles. The number of metals to be analyzed is restricted to the three elements Na, Ca, and Fe in order to rapidly characterize minienvironments from a practicable point of view. Each element represents one ensemble of highly detrimental impurities with respect to contamination from human sources, the environment, or from equipment and corrosive effects. Additionally, they are easily analyzed with sufficiently low detection limits. It is up to the user of this test method to quantify additional elements. The inorganic contamination on silicon wafer surfaces is collected by VPD.

2.2 To quantify Ca and Fe, VPD-TXRF is used due to its sufficiently low detection limits. Na is quantified by VPD-GFAAS. Both analytical methods are widely used for the characterization of surface cleanliness.

2.3 This measurement technique can also be used to check the influence of certain process steps on minienvironments.

2.4 This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish

appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3 Referenced Standards

3.1 SEMI Standards

SEMI E19.4 — 200 mm Standard Mechanical Interface (SMIF)

SEMI E44 — Guide for Procurement and Acceptance of Minienvironments

3.2 Other Documents

ISO¹ 9001 — Quality Systems—Model for Quality Assurance in Design, Development, Production, Installation, and Servicing

SEMI Minienvironments Terminology Workshop Proceedings, April 2, 1993

4 Terminology

4.1 Abbreviations and Acronyms

4.1.1 GFAAS — Graphite Furnace Atomic Absorption Spectroscopy

4.1.2 PFA — Perfluoroalkoxy

4.1.3 PTFE — Polytetrafluoroethylene

4.1.4 PVDF — Polyvinylidene fluoride

4.1.5 TXRF — Total Reflection X-Ray Fluorescence Spectroscopy

4.1.6 ULSI — Ultra Large Scale Integration

4.1.7 VPD — Vapor Phase Decomposition

4.2 Definitions

4.2.1 *box* — a protective container for a cassette and/or substrates.

4.2.2 *cassette* — an open structure that holds one or more substrates (wafer, masks, etc.).

¹ International Organization for Standardization (ISO) 1, rue de Varembe, Case postale 56 CH-1211 Geneva 20, Switzerland

4.2.3 *DI water* — deionized water (specified with specific resistivity $\geq 18 \text{ M}\Omega\text{cm}$, cations: Na, Fe, Ca $\leq 0.2 \text{ }\mu\text{g/l}$).

4.2.4 *minienvironment* — a localized environment created by an enclosure to isolate the product from contamination and people.

4.2.5 *pod* — a box having a Standard Mechanical Interface (SMIF) as per SEMI E19.

4.2.6 *reference wafer* — a cleaned wafer (see Section 8.2).

4.2.7 *sampling wafer* — a cleaned wafer (see Section 8.2), which will be or was exposed to the minienvironment for a certain time.

4.2.8 *standard mechanical interface (SMIF)* — the interface plane between a pod and another minienvironment per SEMI E19.

5 Interferences

5.1 For worst cases, preconditioning of wafers can result in different surface properties indicated by different sensitivities for contamination absorption.

5.2 Non-linearity effects of the TXRF detector are significant at higher concentration levels ($> 10^{13}$ atoms/cm² under the detector area).

5.3 The collection efficiency of VPD depends on:

- the chemistry of the collecting solution
- the bonding of the metal impurities to the silicon surface

- the speed of the droplet, which is rolled over the wafer surface.

5.3.1 Careful procedures are necessary to obtain reproducible analytical results.

5.4 The measured TXRF intensity depends on the accuracy of the procedure to localize and to adjust to the sampled residue. It also depends on the distribution of different elements in and around the residue.

6 Safety Precautions

6.1 Handling HF is dangerous and must be performed according to local regulations for laboratories. Operators must be trained to deal with dangerous chemicals and vapors, especially HF liquid and vapor. Protective clothes and glasses must be worn when handling HF.

7 Apparatus

7.1 The VPD box (Figure 1) is a closed chamber with one or more wafer chucks and a vessel for liquid HF. During operation, HF vapor is formed in the VPD box by evaporating under normal conditions (i.e., room temperature and atmospheric pressure). All materials inside the box must be PTFE, PVDF, PFA, or similar polymer material, which will not be attacked by HF. By reference measurement, it must be assured that the contamination level from the VPD box is below that of the minienvironment.

7.2 The HF vapor dissolves the surface oxide and builds droplets, which can be collected and dried for TXRF analysis or collected and diluted for GFAAS analysis.

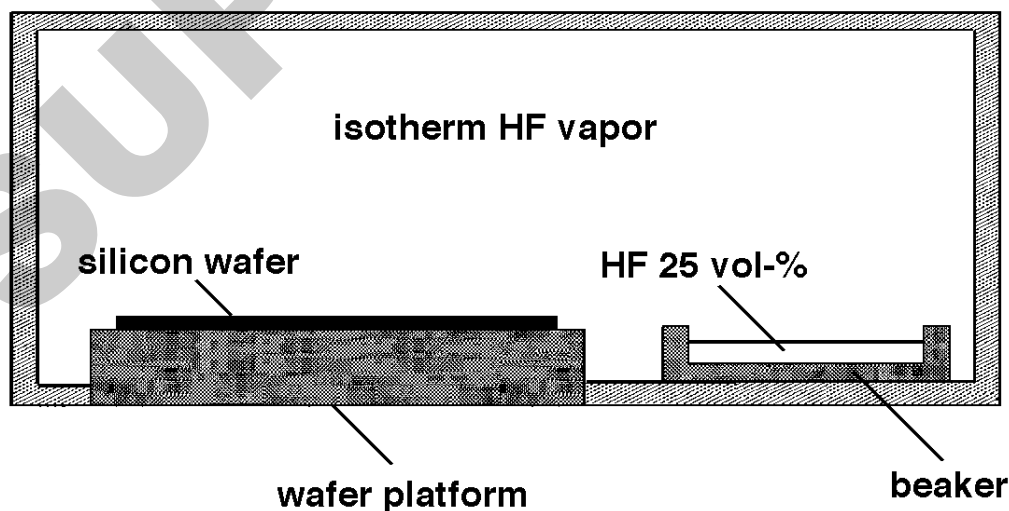


Figure 1
Vapor Phase Decomposition (VPD) Box