# SEMI C23-0714 (Reapproved 0620)
# SPECIFICATIONS FOR BUFFERED OXIDE ETCHANTS

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 19, 2019. Available at www.semiviews.org and www.semi.org in June 2020; originally published in 1981; previously published July 2014.

## 1 Purpose

1.1 The purpose of this Document is to standardize requirements for buffered oxide etchants used in the semiconductor industry and testing procedures to support those standards. Test methods have been shown to give statistically valid results. Alternative methods may be used as long as they comply with SEMI C1 requirements for method validation.

## 2 Scope

2.1 The scope of this Document is grades of buffered oxide etchants used in the semiconductor industry.

**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 Limitations

3.1 None.

## 4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI C1 — Guide for the Analysis of Liquid Chemicals

SEMI C35 — Specification and Guide for Nitric Acid

4.2 *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.

## 5 Terminology

5.1 *Definitions*

5.1.1 *buffered oxide etchant* — any combination of ammonium fluoride and hydrofluoric acid in which the concentrations are expressed in terms of the equivalent relative volumes of 40% ammonium fluoride solution and 49% hydrofluoric acid. In the expression, the relative volumes shall be reduced to a ratio of the smallest whole numbers which properly describes the composition. For example, a 7:1 buffered oxide etchant contains the equivalent of 7 volumes of 40.0% ammonium fluoride and 1 volume of 49% hydrofluoric acid.

## 6 Composition

6.1 For analytical purposes, the absolute concentrations of ammonium fluoride and hydrofluoric acid corresponding to the above definition shall be calculated according to the following equations.

[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



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$$\text{Weight \% } NH_4F = \frac{(\text{volume} \times \text{density} \times \text{concentration})NH_4F}{(\text{volume} \times \text{density})NH_4F + (\text{volume} \times \text{density})HF} \quad (1)$$

$$\text{Weight \% } HF = \frac{(\text{volume} \times \text{density} \times \text{concentration})HF}{(\text{volume} \times \text{density})NH_4F + (\text{volume} \times \text{density})HF} \quad (2)$$

where volume and density are expressed in consistent units and concentration is in weight percent to three significant figures.

6.2 Sample calculation for 7:1 buffered oxide etchant using 40.0% ammonium fluoride, density 1.111 g/mL, and 49.0% hydrofluoric acid, density 1.153 g/mL. The absolute percentage concentration of each component follows:

$$\text{Weight \% } NH_4F = \frac{7 \times 1.111 \times 40.0}{7 \times 1.111 + 1 \times 1.153} = 34.8\%$$

$$\text{Weight \% } HF = \frac{1 \times 1.153 \times 49.0}{7 \times 1.111 + 1 \times 1.153} = 6.33\% \quad (3)$$

## 7 Tolerances

7.1 The tolerances allowed for the absolute percentage of each of the components of a buffered oxide etchant shall be:

| | |
|---|---|
| Ammonium Fluoride: | ±0.5% |
| Hydrofluoric Acid: | ±0.15% |

7.2 For the example above, the permissible range of concentration for ammonium fluoride shall be 34.8 ± 0.5% and for hydrofluoric acid 6.33 ± 0.15%.

## 8 Requirements

8.1 The requirements for buffered oxide etchants for Grades 1 and 2 are listed in Table 1.

## 9 Grade 1 Procedures

9.1 *Hydrofluoric Acid* — Weigh accurately approximately 4.0 g of sample, transfer to a polyethylene beaker, and dilute with water to about 100 mL. Titrate with standardized 1 N sodium hydroxide. The endpoint may be detected colorimetrically by adding 3 drops of methyl red indicator solution and titrating to a definite yellow (no orange) endpoint. As an alternate method, the endpoint may be detected potentiometrically using an HF resistant pH electrode previously standardized in pH 4 and pH 7 buffers. Titrate to pH 6.5 with continuous stirring. Save the solution for the determination of ammonium fluoride.

$$\%\,Hydrofluoric\ Acid = \frac{Volume\ of\ NaOH\,(mL) \times Normality\ of\ NaOH \times 2.001}{Mass\ of\ Sample\ (g)} \quad (4)$$

9.2 *Ammonium Fluoride* — Add 40 mL of neutralized formaldehyde solution (see ¶ 9.2.1) to the solution from the preceding test and stir magnetically for 30 minutes. Titrate with standardized 1 N sodium hydroxide. The endpoint may be detected colorimetrically using 10 drops of phenolphthalein indicator and titrating to a stable pink end point. As an alternative method, the endpoint may be detected potentiometrically using an HF resistant electrode previously standardized in pH 7 and 9 buffers. Titrate to pH 8.5 with continuous stirring.

$$\%\,Ammonium\,Fluoride = \frac{Volume\ of\ NaOH\,(mL) \times Normality\ of\ NaOH \times 3.704}{Mass\ of\ Sample\,(g)} \quad (6)$$



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