

SEMI PV20-0316

SPECIFICATION FOR HYDROCHLORIC ACID USED IN PHOTOVOLTAIC APPLICATIONS

This Standard was technically approved by the Photovoltaic - Materials Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on December 4, 2015. Available at www.semiviews.org and www.semi.org in March 2016; originally published October 2011.

1 Purpose

1.1 This Document standardizes requirements for hydrochloric acid used in the photovoltaic (PV) industry and testing procedures to support those standards. Test methods have been shown to give statistically valid results.

2 Scope

2.1 The scope of this Document is grades of hydrochloric acid used in the PV 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 C27 — Specifications and Guidelines for Hydrochloric Acid

SEMI C35 — Specifications and Guideline for Nitric Acid

4.2 ASTM Standards¹

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

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

5 Terminology

5.1 None.

6 Properties of Hydrochloric Acid

Table 1 Properties of Hydrochloric Acid

Chemical Formula	HCl
CAS Number	7647-01-0

7 Requirements

7.1 The requirements for hydrochloric acid for PV Grades 1 and 2 are listed in Table 2.

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>

Table 2 Impurity Limits and Requirements for Hydrochloric Acid

	<i>PV Grade 1</i>	<i>PV Grade 2</i>
	<i>(Specification)</i>	<i>(Specification)</i>
Assay (HCl)	32.0% to 38.0%	36.5% to 38.0%
Color (APHA)	colorless	10 max.
Free Halogen (as Cl ₂)	To pass test	To pass test
Phosphate (PO ₄)	1000 ppb max.	500 ppb max.
Sulfate (SO ₄)	1000 ppb max.	1000 ppb max.
Aluminum (Al)	300 ppb max.	10 ppb max.
Antimony (Sb)	200 ppb max.	10 ppb max.
Arsenic (As)	200 ppb max.	10 ppb max.
Barium (Ba)	100 ppb max.	10 ppb max.
Boron (B)	100 ppb max.	10 ppb max.
Cadmium (Cd)	--	10 ppb max.
Calcium (Ca)	300 ppb max.	10 ppb max.
Chromium (Cr)	200 ppb max.	10 ppb max.
Copper (Cu)	100 ppb max.	10 ppb max.
Iron (Fe)	200 ppb max.	10 ppb max.
Lead (Pb)	100 ppb max.	10 ppb max.
Lithium (Li)	--	10 ppb max.
Magnesium (Mg)	300 ppb max.	10 ppb max.
Manganese (Mn)	300 ppb max.	10 ppb max.
Nickel (Ni)	100 ppb max.	10 ppb max.
Potassium (K)	300 ppb max.	10 ppb max.
Sodium (Na)	300 ppb max.	10 ppb max.
Tin (Sn)	300 ppb max.	10 ppb max.
Titanium (Ti)	300 ppb max.	10 ppb max.
Vanadium (V)	--	10 ppb max.
Zinc (Zn)	300 ppb max.	10 ppb max.

NOTE 1: Multiple processes exist to make hydrochloric acid. Some of these could contribute byproducts of unwanted organic contamination. If asked, the manufacturer should be prepared to inform the customer about the origin of the hydrochloric acid.

8 PV Grade 1 Procedures

8.1 *Assay* — Accurately weigh a glass-stoppered conical flask containing about 30 mL of water. Deliver from a pipet about 3 mL of sample near the water surface, stopper immediately, and reweigh. Dilute to about 50 mL with water, add methyl orange indicator solution, and titrate with standardized 1 N sodium hydroxide to a red-to-yellow color change.

$$\% \text{Assay} = \frac{\text{Volume of NaOH (mL)} \times \text{Normality of NaOH} \times 3.646}{\text{Mass of sample (g)}} \quad (1)$$

8.2 *Free Halogen (as Cl₂)* — Mix 100 mL of sample and 100 mL of freshly boiled water and cool. Add 0.1 mL of 2% potassium iodide reagent solution (see SEMI C1) and 1 mL of carbon disulfide, and mix. The carbon disulfide should not acquire a pink color in one-half minute.

8.3 *Phosphate* — To 85 mL (100 g) of sample, add 10 mL of sodium carbonate reagent solution (see SEMI C1) and evaporate to dryness on a steam bath in a hood. Dissolve the residue in 25 mL of 0.5 N sulfuric acid. Add 1 mL of