

SEMI F61-0301

GUIDE FOR ULTRAPURE WATER SYSTEM USED IN SEMICONDUCTOR PROCESSING

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1 Purpose

1.1 This guide establishes the typical definitional requirements for an ultrapure water (UPW) system used in semiconductor manufacturing. It is intended to establish a common basis for developing detailed specifications in subsequent documents concerning design, performance and certification and monitoring of UPW systems.

1.2 This document may be used by users and suppliers as a basis for developing site-specific UPW specifications and performance criteria.

2 Scope

2.1 This guide applies to ultrapure water systems used in semiconductor manufacturing facilities for supplying high purity water for chemical dilutions, wafer processing and other manufacturing processes.

2.2 This guide can be used to understand the design elements and functionality of all UPW systems, which includes a Reverse Osmosis (RO) and a Deionization (DI) process. However, it is most applicable to newer designed UPW systems that support submicron linewidth device manufacturing.

2.3 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 Limitations

3.1 This guide does not define the actual specifications generally negotiated between the user and the manufacturer of the UPW system, against which water samples are tested and qualification is passed.

3.2 This guide does not address the testing and prequalification of materials, subassemblies, or components used in a UPW system.

3.3 This guide does not address the protocols and requirements defined by the manufacturer concerning the installation of the UPW system.

3.4 This guide does not address the type, level, or frequency of testing necessary and appropriate for ongoing monitoring of a UPW system.

3.5 This guide does not address the frequency or scope of ongoing maintenance for UPW systems including change out of resin beds and replacement of filters.

3.6 This guide does not intend to cover any of the important safety considerations that relate to the proper installation, operation, or maintenance of a UPW system.

4 Terminology

4.1 Acronyms and Abbreviations

4.1.1 *TOC* — Total organic carbon, also Total Oxidizable Carbon. Refers to organic compounds.

4.1.2 *UPW* — Ultrapure Water System consisting of multiple components including a Reverse Osmosis (RO) and a Deionization (DI) process.

4.2 Definitions

4.2.1 *activated Carbon* — a media filter used to remove oxidizing agents, like chlorine and chloramines, and remove (adsorb) certain TOC compounds.

4.2.2 *anion* — a negatively charged ion.

4.2.3 *cation* — a positively charged ion.

4.2.4 *clarifier* — a piece of water treatment equipment, typically used at municipal drinking water plants, to remove suspended solids from surface water and/or to soften surface water.

4.2.5 *degasification* — the removal of a certain amount of volatile compounds dissolved in water.

4.2.6 *deionization (DI)* — the removal of undesirable ions from water.

4.2.7 *DI storage* — generally refers to a storage tank that contains DI water, located between the primary and polishing ion exchange subsystems.

4.2.8 *DI (deionized) water* — generally refers to water that has passed through a full-train ion exchange system or RO water that has been polished by ion exchange.

4.2.9 *dissolved solids* — contaminants in water that are so small that they are uniformly distributed, including ions and the smallest TOC and silica compounds.

4.2.10 *dual-beds* — an ion exchange scheme where a cation exchange unit is followed by an anion exchange unit.

4.2.11 *electrodeionization (EDI)* — a water treatment technology that utilizes mixed-bed ion exchange plus an electrical potential to remove undesirable dissolved solids. Also referred to in the industry as CDI (Continuous Deionization).

4.2.12 *filtration* — the removal of suspended solids by passing water through some form of solid or semi-solid medium.

4.2.13 *final filter* — generally the final treatment step in a UPW system; used to remove suspended solids.

4.2.14 *full-train DI* — an ion exchange scheme where a cation exchange unit is followed by an anion exchange unit and a mixed-bed ion exchange unit.

4.2.15 *ground water* — water located below the surface of the earth, also called *well water*.

4.2.16 *heat exchanger* — a piece of equipment used to control the temperature of a water stream.

4.2.17 *ion exchange* — a water treatment technology used in a high-purity water treatment application to exchange undesirable cations for hydrogen ions and undesirable anions for hydroxide ions.

4.2.18 *loop* — the distribution system that includes the continuous circulation of UPW from the Final Filter back to the DI storage tank. End users draw off of the loop.

4.2.19 *low-pressure UV units* — units that use UV lamps that have a slight vacuum within. Typically, low-pressure lamps are called 254 nm for ozone destruction and bacterial inactivation or 185 nm for TOC reduction.

4.2.20 *medium-pressure UV units* — units that use UV lamps that have a positive pressure within. Used with bacterial inactivation/ozone destruction lamps or TOC reduction lamps.

4.2.21 *microfiltration* — generally refers to filters designed to remove suspended solids less than one micron in size but greater than 0.1 micron in size.

4.2.22 *mixed-beds* — ion exchange vessels used to polish already purified water, in which both cation and anion exchange occurs.

4.2.23 *multimedia filter* — generally refers to a suspended-solids removal piece of equipment that

contains two or more filtering media such as anthracite and sand, or anthracite, sand and garnet.

4.2.24 *Ozone* — Ozone (O₃) may be injected into the *Supply* and/or *Return* line to control microbiological contaminants and also to enhance the action of TOC breakdown in downstream TOC reducing UV units.

4.2.25 *polishing ion exchange* — a cation/anion exchange step located downstream of primary ion exchange.

4.2.26 *pretreated water* — generally refers to treated water that is fed to reverse osmosis (RO) units.

4.2.27 *primary ion exchange* — the first cation/anion exchange step in a high purity water treatment scheme.

4.2.28 *raw water* — any untreated natural water like river water, lake water, ground water, or seawater. May also refer to the treated feed water that enters a plant from a municipal drinking water source or other source.

4.2.29 *return* — the UPW sent to but not used by end users that returns to the DI storage tank.

4.2.30 *reverse osmosis (RO)* — a filtration technology that utilizes a semi-permeable membrane to remove essentially all suspended solids and the vast majority of all dissolved solids. Generally refers to water (permeate) that has passed through a reverse osmosis (RO) membrane.

4.2.31 *RO storage* — generally refers to a storage tank that contains RO water.

4.2.32 *scale inhibitor* — a chemical used to minimize or eliminate the precipitation of slightly-soluble salts, like calcium carbonate (limestone) or calcium sulfate (gypsum), within water treatment equipment.

4.2.33 *supply* — the UPW sent to end users.

4.2.34 *surface water* — water located on the surface of the earth, such as river water, lake water, and seawater.

4.2.35 *TOC* — total organic carbon, also Total Oxidizable Carbon. Refers to organic compounds.

4.2.36 *treated water* — water that has passed through water treatment equipment and/or received chemical injections in order to modify the dissolved and/or suspended solids content of the water.

4.2.37 *ultrafiltration* — generally refers to filters designed to remove all submicron suspended solids.

4.2.38 *ultraviolet (UV)* — electromagnetic energy with around a 100–400 nm (nanometer) wavelength.