UPW Resins

(Extracted from the Diaion Manuals page 199 to 203)

(3) Semiconductor Industry

Pure water is used as rinse water in the manufacturing processes of the semiconductor integrated circuits and the relevant products in the semiconductor industries. The quality of the pure water in these industries is required to be extremely high since the qualities and the yields of the products are affected seriously by it, and thus such pure water is called as "ultra pure water". The required quality is becoming as high as theoretically pure water recently in accordance with the rapid advancement of the integration of the integrated circuits. Table V-2-4 summarizes the relations between integrations and ultra pure water qualities.

[Table V-2-4] Technology Requirement for Wafer Environmental Contamination Control: excerpts from ITRS 2005

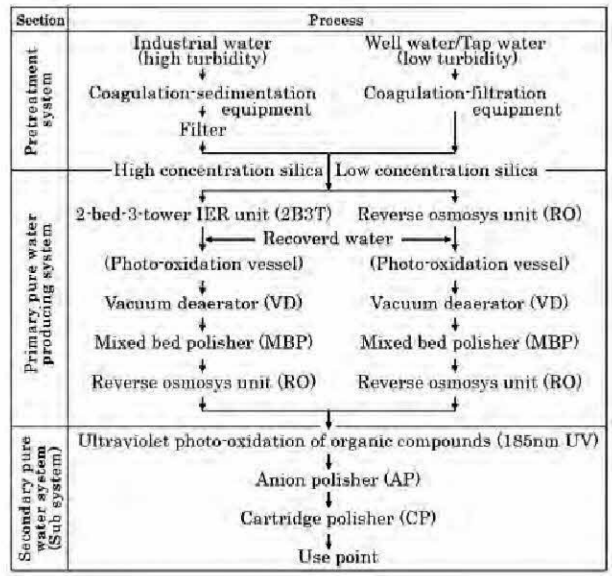
Year of production	2005	2008	2010	2013	2016	2020
DRAM 1/2 pitch (nm) (contacted)	80	57	45	32	22	14
Ultrapure Water [L]						
Resistivity at 25 ˚C (MΩcm)	18.2	18.2	18.2	18.2	18.2	18.2
Total oxidizable carbon (ppb) POE	<1	<1	<1	<1	<1	<1
Bacteria (CFU/L)	<1	<1	<1	<1	<1	<1
Total Silica (ppb) as SiO_2 [P]	<0.5	<0.5	<0.3	<0.3	<0.3	<0.3
Number of particles > critical size (/mL) [A] POE	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dissolved oxygen (ppb) (contaminant based) [N] POE	<10	<10	<10	<10	<10	<10
Dissolved nitrogen (ppm) [J]	8.12	8.18	8.18	8.18	8.18	8.18
Critical metals (ppt, each) [F]	<1	<0.5	<0.5	<0.5	<0.5	<0.5
Other critical ions (ppt each) [W]	<50	<50	<50	<50	<50	<50
Temperature stability (K) POE	±1	±1	±1	±1	±1	±1
Temperature gradient in K/10 minutes [U] POE for immersion photolithography	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

* ITRS 2005: The International Technology Roadmap for Semiconductors, 2005
* The units of ppm, ppb and ppt are all in weight by weight
* POD: Point of Delivery, POE: point of Entry, the others are at POU, Point of Use
* Boron (50ppt) and reactive silica (300ppt) as UPW operation parameters are both excluded from this table
* [A] Critical particle size is one half of the design rule
* [F] Critical metals and ions include Al, As, Ba, Ca, Co, Cu, Cr, Fe, K, Li, Mg, Mn, Na, Ni, Pb, Sn, Ti, and Zn
* [W] Other critical ions include ammonia, F, Cl^-, NO_2^-, NO_3^-, PO_3^{2-}, Br^-, SO_4^{2-} and other inorganic ones. However, there are no reports that these ions of over 50 ppt in UPW do some interference against the normal operations. The thresholds of organic ions, e.g. acetic acid, formic acid, propionic acid, citric acid and oxalic acid, are still being investigated.

The elementary technology is ion-exchange only except for preparations such as coagulation in general pure water manufacturing. On the contrary, reverse osmosis, ultra filtration and sterilizer with UV irradiation are also elementary technologies in the manufacturing of ultra pure water. The system configurations depend on the qualities of raw water and treated water. Fig.V-2-8 illustrates a process flow.

The role of IERs is to eliminate electrolytes in raw water and to make its electrical conductivity as identical to the theoretical pure water as possible. IERs are synthetic polymers and contain themselves a small amount of elusive impurities. Hence, in manufacturing of ultra pure water applied are the highly refined IERs such as DIAION® UP series, SKT10L, SKT20L, SAT10L and SAT20L.

In the primary pure water systems, the system configurations depend on silica (SiO_2) densities. They are, however, generally combined with 2-bed-3-tower (2B3T) IERs and a mixed-bed polisher (MBP) to remove electrolytes, a vacuum deaeration tower (VD) to remove dissolved oxygen and a reverse osmosis (RO) to remove fine grains, bacteria and organic compounds.



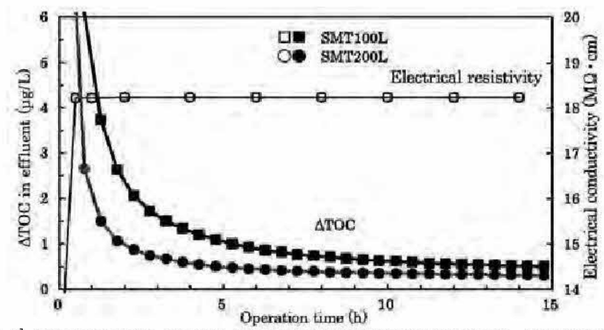
[Fig.V-2-8] Manufacturing process flow of ultra pure water (24)

The manufacturing system of ultra pure water consists of preparation, the primary pure water and the secondary pure water subsystems demonstrated in Fig.V-2-8. IERs are applied both in primary and secondary subsystems, but the roles in both subsystems are quite different. In the secondary subsystem, the raw water is treated with ultraviolet photo-oxidation of organic compounds (185nmUV), an anion polisher (AP), a mixed-bed cartridge polisher (CP) and an ultra filtration. The IERs are highly purified, and should not be regenerated lest they are contaminated by regenerants.

[Table V-2-5] Removal of metallic impurities with DIAION® SMT100L and SMT200L (25)
IER: 500mL, Flow rate SV = 30, observed after 24hours from the start (unit: ng/L)

	SMT100L	SMT200L
Na	1.9	<0.1
Mg	0.1	<0.1
Al	0.5	<0.1
K	0.2	<0.1
Ca	1.4	<0.1
Cr	<0.1	<0.1
Fe	0.3	<0.1
Ni	<0.1	<0.1
Cu	<0.1	<0.1
Zn	0.9	<0.1
Pb	0.2	<0.1

Table V-2-5 shows the removal of metallic impurities with DIAION® SMT100L and SMT200L that are highly purified. The quality change of the treated water is also demonstrated in Fig.V-2-9.



[Fig.V-2-9] Quality of the treated water with DIAION® SMT100L and SMT200L (25)
Column: 30mm ϕ ×1000mm H, IER: 500mL, Flow-rate:15 L/h (SV=30)