OVIVO™
Bringing water to life℠

Water specialists for the Semiconductor Sector

creating value in water through innovation, creativity and expertise

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A New Global Force in Water

As society and the global economy demand more and more from water, there is a growing requirement for ever more specialist applications to manage clean water, to create specialist process waters, to treat wastewater, to extract energy from wastewater and to champion the reuse of water.

The 2010 merger of Eimco Water Technologies, Enviroquip, Aqua Engineering and Christ Water Technology plus many smaller specialist firms allows Ovivo to offer a unique combination of advanced solutions, probably the most significant application knowledge base in the world and some of the best brains in the business.

Ovivo aims to become the water partner of choice for clients in the public and private sectors and the leading source of water expertise for engineers and consultants across the globe.

For further information, visit
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> *"Ovivo - creating value in water through innovation, creativity and expertise in clean water, process water, wastewater treatment, waste-to-energy and water reuse markets across 5 continents."*

Ovivo - bringing water to life

Our Role in your Industry

The fabrication of semiconductor devices requires large volumes of ultrapure water (UPW) and generates large volumes of wastewater. Only the purest possible water is acceptable for use in semiconductor manufacture. Ovivo's technology removes impurities from water at the limits of their detection. The ultrapure water produced is of ultimate quality and therefore of ultimate reliability.

Semiconductor manufacturers use many proprietary chemicals and production processes. These produce a wide range of wastewaters of varying qualities. A reliable wastewater treatment and reclamation system assures protection of the environment and conserves those resources needed for growth in the semiconductor industry. The key areas that Ovivo creates value for semiconductor manufacturers are its capabilities to:

- **Reclaim** (capture, reuse or recycle) water that would normally go to waste;
- **Recycle** (capture, treat/refurbish) effluent discharged from a process and bring it back into the same process; and
- **Reuse** effluent from one process, treat it as required, and then utilize it in another.

The increasing sophistication of Ovivo's water and wastewater treatment methods are major elements in our drive to achieve maximum water reclaim and to reduce the costs of water extraction.

Water is a raw material. Handling it is a responsibility. Based on its detailed knowledge of the processes and requirements of semiconductor manufacturing, Ovivo is able to provide total water management solutions for the manufacture of:

- Wafers.
- Chips.
- Liquid Crystal Displays (LCDs).
- Thin Film Transistors (TFTs).

Ovivo integrates each process step, from project identification through construction to commissioning. We offer total solutions that encompass operator training, client services, system operation and maintenance, which can be governed by client-specific service contracts according to client needs.

Beginning with an analysis of a client's specific manufacturing conditions, Ovivo designs and supplies customized water treatment solutions to meet the exceptionally high standards of the semiconductor industry. It can supply complete ultrapure water systems, recycling, Chemical Mechanical Planarization (CMP) and wastewater treatment plants. Ovivo's global specialization enables it to implement systems that treat local regulatory environmental requirements as minimum standards.

Electrical Control and Monitoring
A range of easy maintenance products accompanies the detailed engineering of running processes. Continuous improvements in industrial IT systems over recent years have enabled Ovivo to offer ever-more sophisticated features and services. A WAN Ethernet connection provides software assistance and plant analysis so Ovivo's team can react rapidly to operator requests and guarantee safe process handling as well as optimal plant monitoring. Supervisory workstations enable operator control and monitoring of all relevant process information such as thresholds, sequence starts, and other optimization data. Bumpless and backup switching procedures guarantee full availability and reliability. Polishing sections, are capable of running in stand-alone mode, considerably limiting the risk of shut-down when pure water is introduced to processes. Via Ovivo plant audits our engineers' comprehensive experience and proven design capabilities ensure maximum reliability and lowest costs of ownership.

Creating Value

"Ovivo's unrivalled expertise in producing water of a quality at the limits of detection and beyond and to offer the most sophisticated wastewater recovery systems ensure that water usage and product failure is minimized."

How we operate in your industry

Ultrapure Water

The ultrapure water needed for semiconductor manufacture is the purest water feasible. It is produced by combining conventional, membrane, ion exchange and/or thermal treatment processes.
Ovivo's ultrapure production process provides:

- Ultrapure water (UPW) with total organic content (TOC) of <0.5 ppb.
- Lowest boron concentrations.
- Lowest cost of ownership.
- A robust system for removal of the most difficult organics in raw water.
- Turnkey systems for highest recycling rates.
- Patented Tocsorb® system for high organic rinse water treatment.
- Recycling of backgrind (BG) and chemical mechanical polishing (CMP) rinse water.

Pre-treatment

Field experience shows that multimedia filtration with microflocculation followed by an activated carbon filter unit is one of the most effective pre-treatment combinations to remove traces of suspended matter and to reduce fouling to the lowest possible levels. Raw water ultrafiltration is an alternative with even better outlet qualities. To a certain extent, activated carbon filters reduce TOC levels of reclaimed last rinses, too.

The Make-up Process
Osmostil® reverse osmosis is used successfully in water purification to remove the bulk of ions, bacteria, particles and TOC. Depending on the raw water analysis, the combination of demineralization by ion exchange processes and reverse osmosis may be a better choice.

Gases such as oxygen and CO_2, as well as some volatile organics, are subsequently removed in a degasifying unit (e.g. a vacuum degasifier or membrane degasifier). Water is then purified to almost the highest theoretical resistivity level by three mixed-bed ion exchangers in a merry-go-round arrangement with external regeneration (MOVEX). A demand for chemical-free technology may also lead to the application of electrodeionization (EDI) systems.

Polishing

Any remaining TOC is destroyed by Lumostil™ UV units and, to achieve low oxygen levels, an additional degasser system can be employed. All remaining ionic impurities are removed by polishing mixed-bed ion exchangers. UPW is then purified from the last remaining particles by Ultrastil™ ultrafiltration systems before transfer to cold or hot users. Unused ultrapure water is continuously recirculated to the UPW tank for repurification. Ovivo provides design, installation, supervision and certification of PVDF and/or PP distribution systems. Typical specifications of ultrapure water for semiconductors with a structure of 45 nm are shown overleaf:

Parameter	Unit	Guaranteed value	Expected value
Resistivity at 25 °C	MΩ cm	> 18.2	> 18.2
SiO_2 (total)	ppb	< 0.5	< 0.1
TOC	ppb	< 1.0	< 0.3
O_2	ppb	< 10	< 1.0
Particles >0.05 µm	n/l	< 200	< 100
Bacteria	CFU/l	< 1	0
Dissolved nitrogen	ppb	8 - 18	8 - 18
Critical metals	ppt	< 1	< 0.5
Critical ions	ppt	< 50	< 10
Boron	ppt	< 50	< 10

Degasifying

Several semiconductor fabrication applications require low oxygen levels, which are facilitated after the polishing stage via degasifying.

Cold and Hot Vacuum Degasifying towers - capable of handling large amounts of water up to a few hundred m^3/h with final oxygen levels in the 1-9 ppb range. Whenever low levels of oxygen are needed, the conventional vacuum degasifier has proven to be a highly practical technology.

Membrane Degasifying-units offer a sophisticated method for removing oxygen from water. A four-stage process reduces oxygen levels to client requirements. The membrane contains thousands of microporous polypropylene hollow fibres knotted into an array that is wound around a distribution tube. Contactors facilitate gas transfer to or from an aqueous stream without dispersion.

Wastewater Generation and Treatment

Semiconductor fabrication processes Chemical Mechanical Planarization (CMP, lithography, etching, stripping and cleaning) result in a variety of wastewater compositions (CMP, BG, acid and alkaline waste, metal-bearing waste and organic waste). These require treatment to meet stringent global reclamation and discharge regulations. Committed to protecting the environment, conserving resources and to meeting new manufacturing challenges as they occur, Ovivo has developed several state of the art wastewater treatment processes to meet current and future reclaim and discharge requirements. Ovivo's wastewater treatment technology features:

- Lowest chemical consumption.
- Lowest cost of ownership.
- Fluoride discharge limit < 10 ppm.

CMP and BG Wastewater Reclamation

CMP is an essential process in semiconductor fabrication. The resultant wastewater can be treated by flocculation and sedimentation to remove slurry particles. The advantages of Ovivo systems are:

- Hydrogen Peroxide control avoids sludge flotation.
- Minimal chemical consumption and sludge generation.
- Treated water meets stringent discharge requirements.
- Designed for long asset life.
- Enhanced reliability.

Treatment of Copper CMP Wastewater
Ovivo's advanced oxidation process utilizes a tolerant but advanced process to remove copper from copper CMP wastewater. The process adds a catalyst to copper waste utilizing the oxidant present to form a strong oxidizer. The strong oxidizer breaks down the complexed copper and reduces the wastewater's organic concentration. Copper can then be precipitated as copper hydroxide and removed with the slurry particles. Ovivo's advanced oxidation process is notable for:

- Lowest chemical consumption.
- Achieving stringent wastewater discharge requirements.
- Reducing not only copper, but also organics.
- Simple, flexible and cost-effective operation.
- Enhanced reliability.

Fluoride Wastewater
Treatment of Fluoride-bearing Wastewater
Wastewater quality fluctuates continuously, but Ovivo treatment systems produce water of stable quality while minimizing chemical consumption.

Fluoride-bearing wastewater is treated in a common specialized treatment system comprising calcium fluoride precipitation, flocculation and solid/liquid separation. Fluoride removal by precipitation as calcium fluoride is one of the most well defined processes for removal of high fluoride concentration from fluoride-bearing wastewater. Calcium salts, such as calcium chloride and calcium hydroxide, may be used to precipitate fluoride as insoluble calcium fluoride salt; the advantages of Ovivo systems are:

- Lowest chemical consumption; state of the art control minimizes calcium consumption and optimizes treated water quality.
- Minimal sludge generation; no floating sludge.
- Fluoride discharge limit < 10ppm.
- Lowest cost of ownership.
- Designed for long asset life.
- Enhanced reliability.

Fluoride Polishing
The Fluorex™ process can be used to achieve low fluoride concentration that cannot be achieved by precipitation. Fluoride in a diluted fluoride stream or in the effluent of the fluoride precipitation system is removed to less than 1 mg/l. The advantages of the Fluorex process are:

- Simple and very reliable.
- Low capital and operating cost.
- Can be used to remove fluoride selectively regardless of the concentration of other anions.
- It is the most economical and reliable treatment alternative to remove low fluoride concentration from dilute acid wastewater (microelectronics effluent).
- Enhanced reliability.

Acid Waste Neutralization

Ovivo's robust and reliable acid waste neutralization system offers maximum flexibility and efficiency. Ovivo uses a state of the art control system to minimize chemical consumption. Ovivo's neutralization system has these benefits:

- Simple and very reliable.
- A state of the art control system guarantees minimal chemical consumption.
- The robust materials are compatible with aggressive chemicals.
- Designed for long asset life.
- Enhanced reliability.

Low Organic Rinse Water Reclaim
Low TOC rinse waters (second and final rinses and organic-free rinses) account for approximately 40% of the total UP water consumption in an average semiconductor fabrication facility; the average quality of this rinse water is:

Conductivity	(µS / cm)	< 2000
TSS	(mg / l)	< 1
TOC	(ppb)	< 200
H_2O_2	(mg / l)	< 200

The main chemicals in this rinse water are:

- Acids (H_2SO_4, H_3PO_4, HF, HCl).
- Ammonia and ammonium fluoride (NH_4OH, NH_4F).
- Hydrogen peroxide (H_2O_2).
- Traces of organics.

High Organic Rinse Water Reclamation
Rinse water containing organics generated from several cleaning processes and organic baths are recovered for recycle or reuse by Ovivo's specialized organic removal systems. These comprise advanced monitoring and control devices followed by activated carbon filters and various organic removal steps.
The entire process is specifically designed for the type and concentration of the various organic compounds.
The average quality of this rinse water is:

Conductivity	(µS / cm)	< 500
TSS	(mg / l)	< 1
TOC	(ppb)	< 5000
H_2O_2	(mg / l)	< 200

The main organic contaminants are:

- Drying agents.
- Developers.
- Cleaners, solvents and surfactants.

Creating Value

Committed to protecting the environment, conserving resources and to meeting new manufacturing challenges as they occur, Ovivo develops state of the art wastewater treatment processes to meet current and future reclaim and discharge requirements.

Case Study **Semiconductors Ultrapure Water Retrofit**

Chip manufacturer, South East Asia

Brief
In 1992 we installed a turnkey ultrapure water (UPW) plant for a prestigious chip manufacturing client in South East Asia; in 1995, the client expanded his factory utilizing a cheaper supplier.

In 1999 our client in South East Asia contacted us to advise that the UPW plant installed by the cheaper supplier at their semiconductor wafer manufacturing facility was not meeting their final product specification requirements, and to ask for our help in providing a workable solution.

Solution
Engineers were dispatched from Switzerland to evaluate the installation and to examine the identified problems. Within four days, our engineering team had developed their recommended solution: a complete refit and expansion of the newly-installed plant.

Importantly, the client required that the UPW plant could NOT be shutdown and must deliver continuous UPW to the required quality into the wafer manufacturing facility.

Instructed to proceed, we replaced major key components of the supplier plant (obsolete ion exchange vessels, pumps, pipes, etc.) to enhance the UPW process. Restructuring of the PLC automatic and control functions and implementing our control philosophy for the refitted plant proved challenging, but within seven months, our work was completed and the client's trust in Ovivo's knowledge and expertise was confirmed.

How we created value

- Maintained UPW supply throughout the retrofit.
- Maintained UPW quality throughout the retrofit.
- Implementation of complementary systems and equipment.
- Maintained plant footprint.

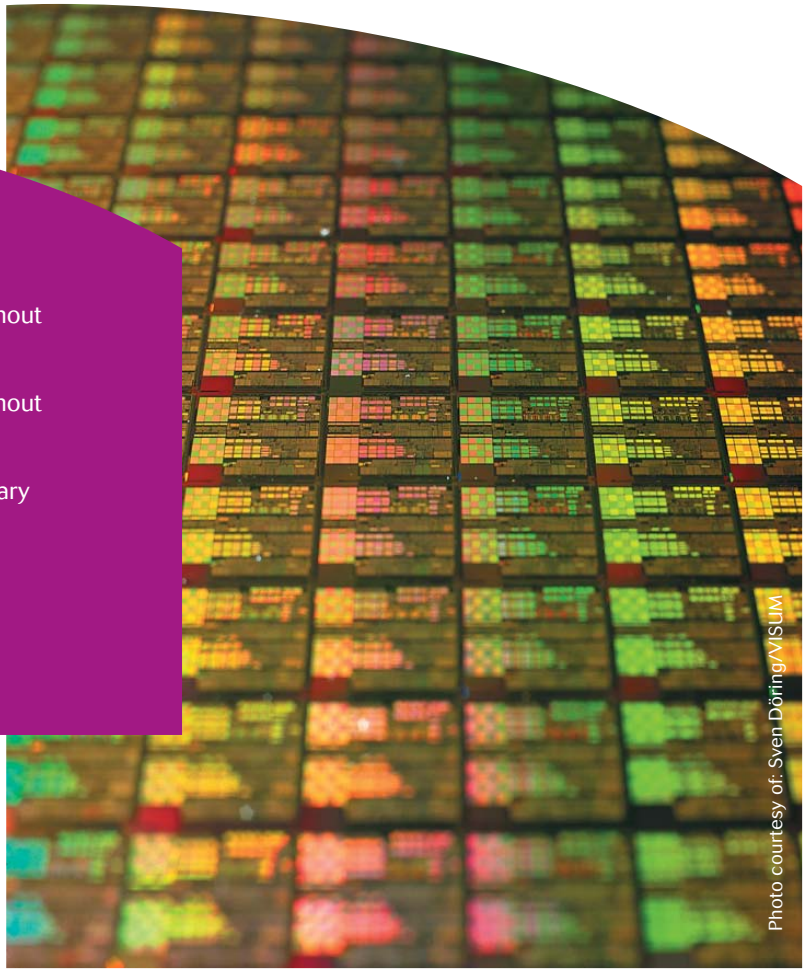


Photo courtesy of: Sven Döring/VISUM

Outcome
The question every evening during the refit:
"Will the plant survive the night with the changes we made today, or will we get a call?"

During the execution phase of this seven month project, there were very few out of hours call-outs for our engineering team, and each call-out was very minor in nature. UPW output from the expanded plant was doubled in capacity. Since switch-on, the new plant has continued to operate trouble-free and within its operational parameters.

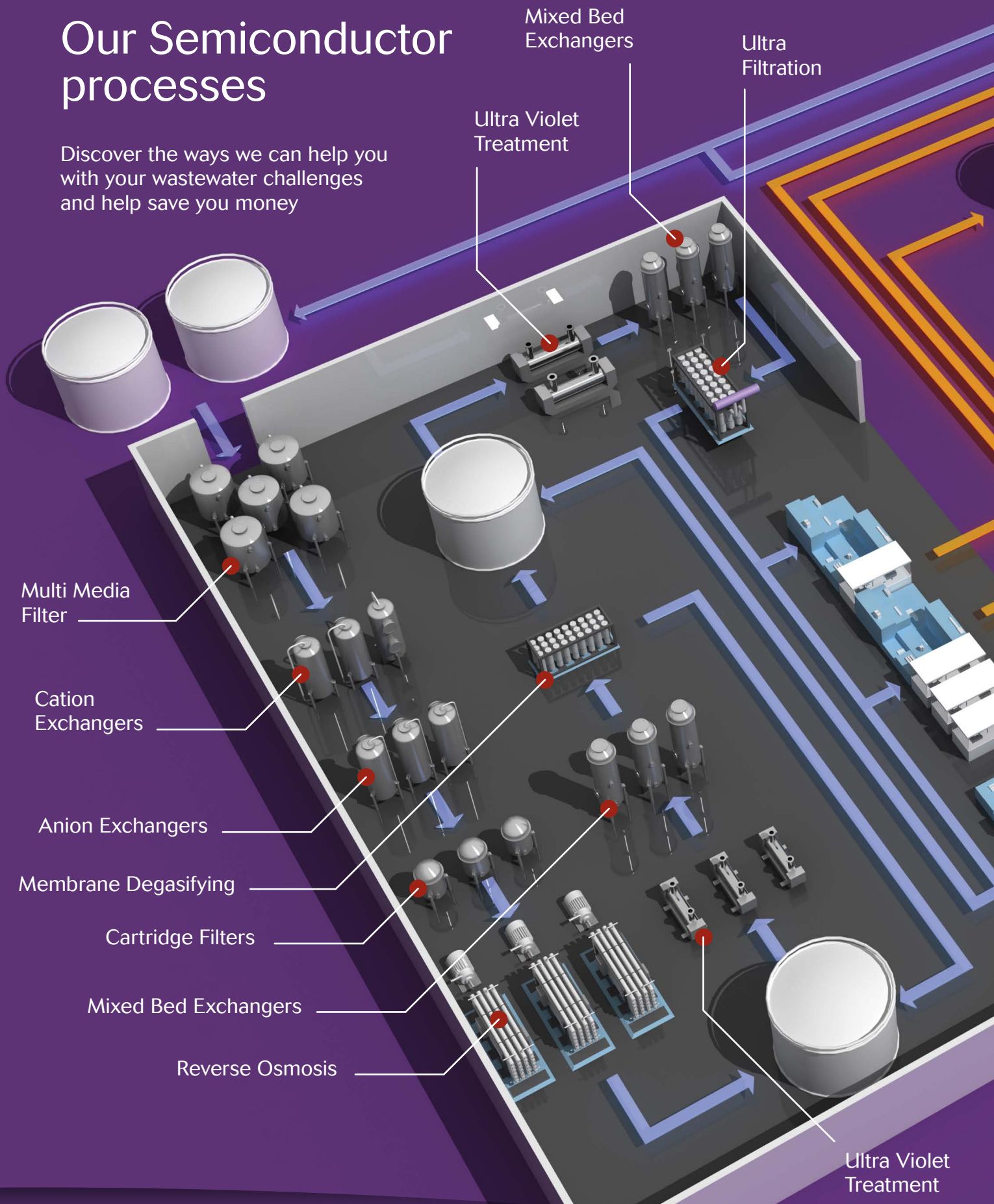
Follow-on work:
In 2006 the client requested a large turnkey UPW plant.

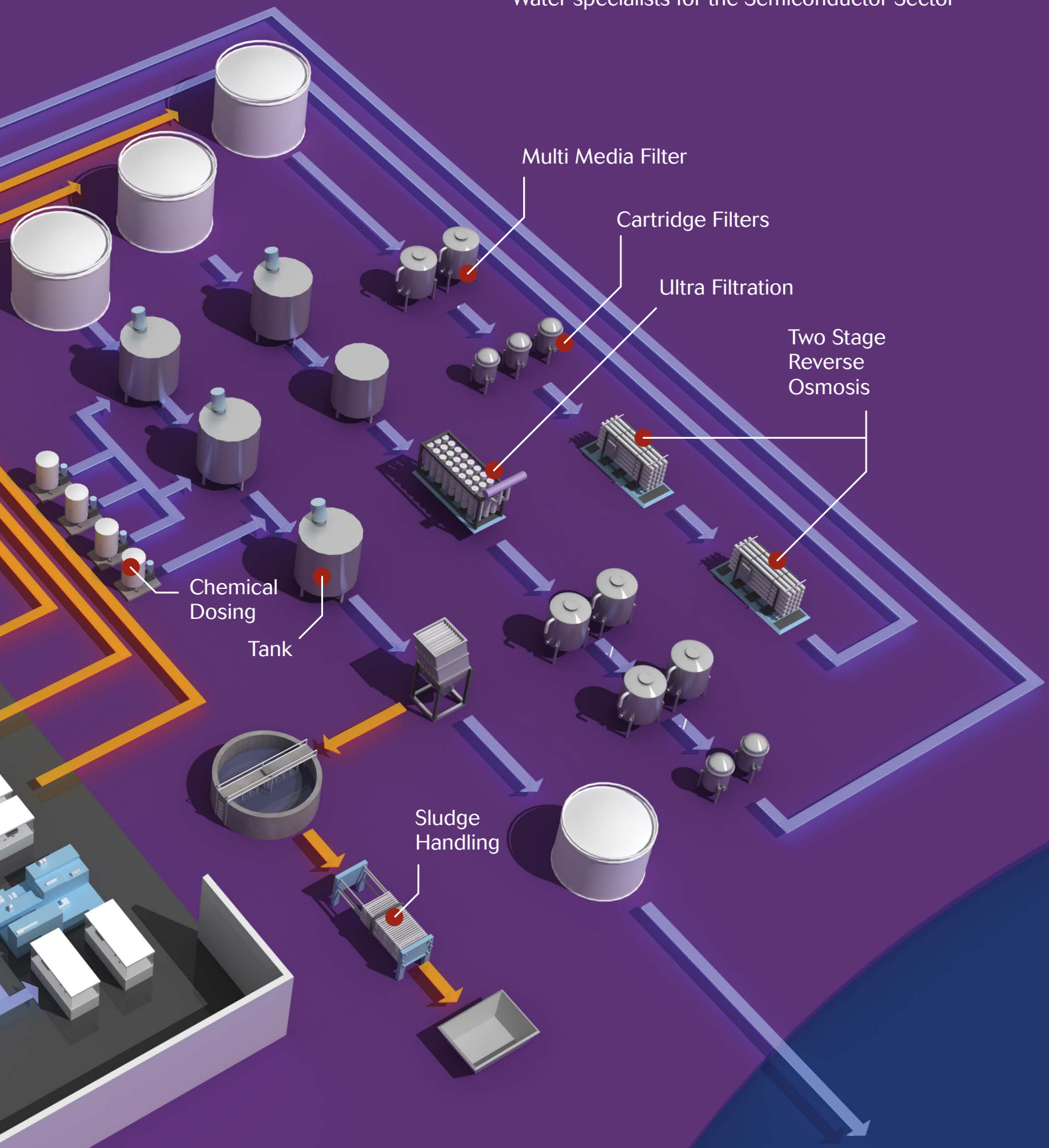
In 2007 we were back to retrofit our original 1992 plant on behalf of the client.

Photo courtesy of: Sven Döring/VISUM

Our Semiconductor processes

Discover the ways we can help you with your wastewater challenges and help save you money





Case Study

Semiconductors UPW, South East Asia

Brief
Ovivo integrated turnkey solutions are particularly effective when applied to the exacting ultrapure water treatment requirements of the semiconductor manufacturing sector. A team from the Ovivo group of companies was awarded the contract to provide a complete ultrapure water (UPW) treatment plant for one of the region's largest flash memory manufacturers. Ovivo's engineers assumed overall responsibility for the installation and for guaranteeing process integrity for the ultrapure water treatment project.

Solution
NAND Flash memory, is a powerful technology that helps increase mobility and functionality in a wide range of electronic devices. NAND Flash memory is currently the fastest-growing segment in the semiconductor industry - thanks in no small part to the popularity of the applications in which NAND Flash is used: consumer electronics such as iPods, removable storage and handheld communication products.

For the production of wafers, microchips and solar cells, ultrapure water of the highest quality is required. Ovivo's ultrapure water plants and systems for treatment of process wastewater are characterized by optimal and environmentally friendly process combinations.

Outcome
Ovivo's technologies facilitate:

- Pretreatment.
- Make-up.
- Polishing.
- Distribution systems.
- Recovery.
- Reuse & Reclaim.

Since switch-on of the new plant, it has continued to operate trouble-free and within its operational parameters.


Photo courtesy of: Sven Döring/VISUM

How we created value

- Ovivo technology is instrumental in production in the semiconductor sector's fastest-growing segment.
- Ovivo teams operate effectively in the world's toughest regulatory regimes.
- Total designed solutions ensure quantity and quality of output where water ultrapurity is essential.

Prolonging the efficient life of your assets

Ovivo takes a business-orientated view of total operating costs in water and wastewater. Each office can draw upon global best practice and in-depth application knowledge to ensure the efficient and effective running of water solutions within clients' businesses.

Ovivo's commitment to clients is total, with experts dedicated to the provision of high quality operational support, maintenance, refurbishment and specialty chemical supply.

Ovivo teams worldwide can test and confirm the operating capabilities of systems via regular inspections, either onsite or remotely. They will calibrate water treatment equipment periodically, as specific client service contracts require it.

Your local Ovivo team operates a quality system that conforms to ISO 9001 ensuring that:

- Communicating is as easy as possible.
- Local resources are used wherever possible.
- Costs are kept to a minimum.

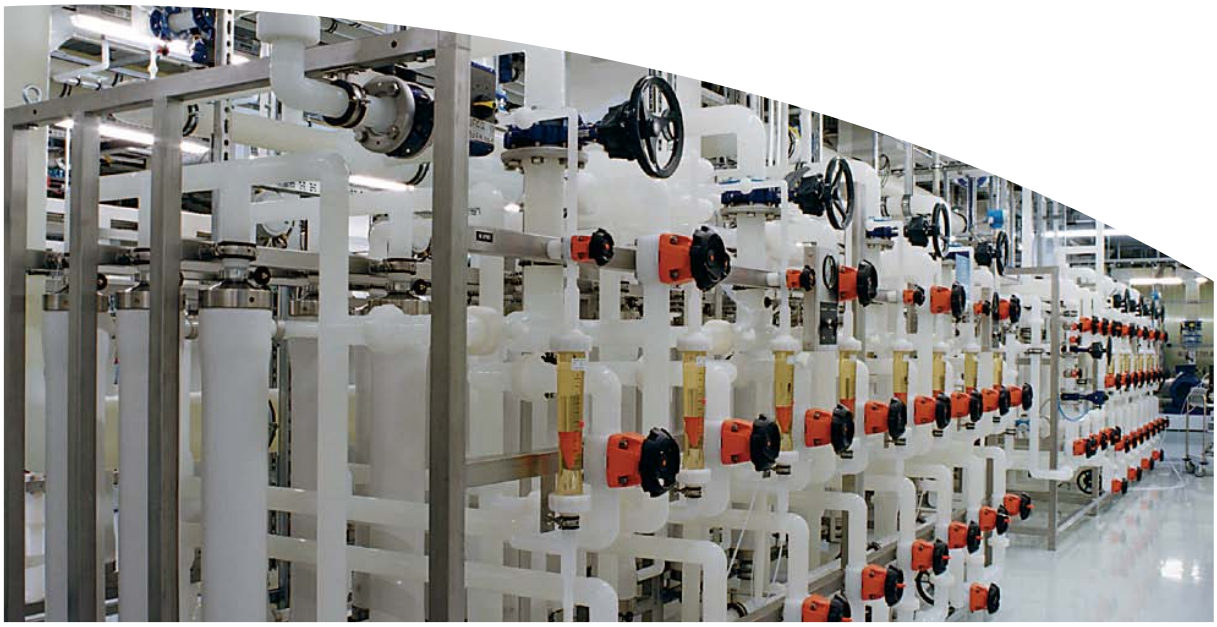
Backed by a comprehensive telephone support service and spare part supply agreements, Ovivo's commitment is to develop productive, long-term customer service relationships with every client. Its teams ensure that plants are kept in optimum condition, minimizing downtime for your business and enabling you to operate at optimal efficiency.

Creating Value

"Water is a living environment, an energy medium and a transport medium; it is also an important element in all types of production. Ovivo is fully aware of its responsibilities in maintaining water as a raw material, and our contribution will become even more important in the future."

Applications and Solutions

	UPW	Wastewater	Reclaim	CMP	Copper
Reverse Osmosis	●	●	●	●	
Ultrafiltration	●	●	●	●	
Membrane Degaser	●				
EDI	●				
Ion Exchange	●	●	●	●	●
Adsorption	●	●	●		
UV	●	●	●		
Ozone	●		●		
Flocculation	●	●		●	●
Precoat Filtration	●				
Sedimentation	●	●		●	●
Multimedia Filter	●	●			●
Advanced Oxidation	●	●	●	●	●
Precipitation		●			
Dewatering		●			
Activated Carbon Filter	●	●	●	●	●
Neutralization		●			
Electro-Reclaim					●



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