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Clean Processing

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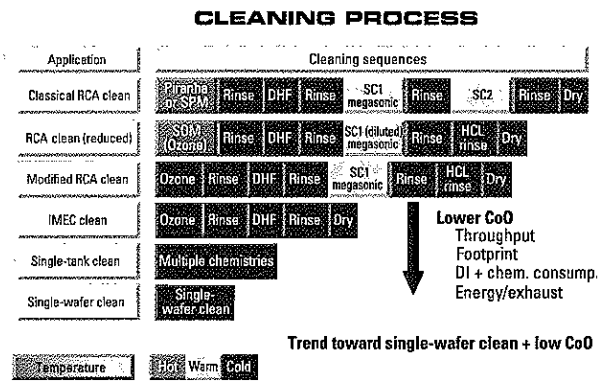
Advanced Role of Ozone in Wet Processing

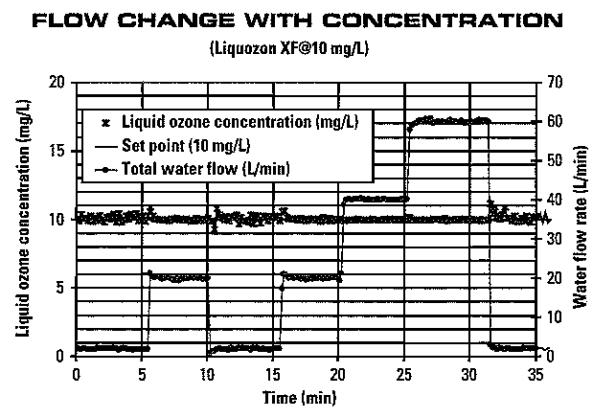
Ozone is an environmentally friendly and highly reactive form of oxygen that has been used for several years in semiconductor fabrication in the deposition of doped and undoped oxide films

Ozone is generated at the point of use and can be easily converted to oxygen IMEC (Leuven, Belgium) developed a wafer cleaning process that, compared with the widely used RCA clean, shows better or comparable performance This new cleaning process, made possible when ozone is dissolved in deionized or ultrapure water, eliminates the need for sulfuric or hydrochloric acids and significantly reduces the number of steps in the RCA clean (Fig 1) In applications where sulfuric acid and hydrogen peroxide mixtures are used, ozone can be added to restore the peroxide and greatly extend the effectiveness of the bath In both cases, significant savings in chemical disposal costs and a very desirable positive environmental impact are achieved

Researchers at MKS Instruments-ASTeX Products (Berlin) developed LIQUOZON a fully integrated system that delivers ozonated water for use in such critical cleaning applications Using LIQUOZON, ozone cleanings led to better gate oxide quality (transconductance) subthreshold slope, charge-to-breakdown (Q_{BD}), time-to-breakdown (T_{BD}), and mobility with the least amount of roughness and interface scattering In addition, the susceptibility of the surface to particle and organic contamination is significantly reduced



1. Progressive steps to achieve a single-wafer wet clean (Source: MKS-ASTeX)



2. LIQUOZON can handle the variation of flow changes and liquid ozone concentrations (Source: MKS-ASTeX)

A key differentiator of this technology is the high ozone concentrations achieved by using a proprietary efficient contactor specifically developed for LIQUOZON The residual O_3 gas is converted back to O_2 in an integrated ozone destruct unit Also different is the SEMOZON ozone generation technology that creates the highest-purity ozone gas through the partial conversion of oxygen into ozone in a silent plasma discharge The ozone generator incorporates an inlet for O_2 and an outlet for the O_2/O_3 mixture

LIQUOZON provides high-purity, dissolved ozone in concentrations of 5-90 ppm at water flows of 5-60 L/min Typical dissolved ozone applications include wet wafer cleaning, photoresist strip, contaminant removal, surface conditioning, oxide growth and pre-gate clean/pre-diffusion The systems are available in two models: the LIQUOZON 100 for flows up to 30 L/min and the LIQUOZON XF for extended flow operation of up to 60 L/min They include closed-loop concentration control and an intelligent electrical interface designed to handle variable flow rates at the desired ozone concentration Because of their high water-flow capability, they can feed up to four wet processing tools simultaneously An optional accessory, the FLOW CONTROL BOX, allows the system to feed multiple points of use at different concentrations and flows simultaneously from a single system

The technology can handle future challenges if the requirements are a matter of high concentration and flow However, when considering a single-wafer application such versatility may not be needed Instead, a smaller system with lower flow rate would be satisfactory LIQUOZON has the flexibility to cover a very wide range of ozone concentration and flow, said Christiane Gottschalk, product marketing manager of MKS-ASTeX. And with help of the closed-loop concentration control, the delivery of stable ozone concentration at variable flow rates is possible (Fig 2) Therefore, it is perfect for use in the manufacturing process with fixed process recipes, but also for process development where a wide range of flexibility is required ' •

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ASTeX® LIQUOZON®
Ozonated Water Delivery Subsystem

The MKS **LIQUOZON** subsystem is designed to provide the highest concentration of dissolved ozone available — from 5 - 90 ppm to high purity semiconductor and flat panel applications such as wet wafer cleaning, photoresist strip, contamination removal, surface conditioning and oxide growth. Ozone is an environmentally friendly alternative to many process chemicals. Use of the LIQUOZON subsystem reduces toxic chemical consumption and disposal costs. In addition, the LIQUOZON system's closed-loop control coupled with an intelligent electrical interface allows delivery of ultraclean ozonated water at variable flow rates to multiple tools.