## Mass Laminate Manufacturer Builds Bridge to Zero Discharge

*Recover* and *reuse* are increasingly important environmental buzzwords, but most people associate them with copper, nickel or precious metals. At QLP Laminates in Anaheim, CA, the currently best recoverable/reusable commodity is water. By integrating treatment technologies that include ion exchange, membranes, precipitation and evaporation (in the future), the company is enhancing product quality, saving money on water and treatment costs, and building a bridge to zero discharge.

Being recognized as a supplier of a high-quality product is very important to QLP Laminates of Anaheim, California. The company produces thin laminate, prepreg and mass laminate (semi-finished multilayer boards up to

16 layers) for the printed circuit board industry. As a matter of fact, at 225 employees and \$30 million in annual sales, QLP likely holds title to being the largest mass laminate producer in the U.S. A large percentage of its products ultimately ends up in automotive (under the hood)



In the planning stages and even now, working sessions are a matter of course for the "team"—QLP staff members and representatives of the equipment supplier. (L-R) Juzer Jangbarwala, president, Hydromatix, Inc.; Bob Keally, materials manager at QLP Laminates; Abdul Jaber, safety and environmental engineer; and Dr. Valentina Perakh, wet process engineer.

electronic products. Approximately 35–40 percent of the mass laminate used in the U.S. is processed at QLP's facility in Anaheim.

In mass laminate and PCB manufacturing operations, the involvement of metals, photoresists, developers, strippers and cleaners make recovery and reuse of metals complicated. Process solutions are highly sensitive to any kind of contamination—a likelihood that is introduced when recovered water is returned to the process rinse tanks. Although the goal of recovering and reusing metals is desirable, it is usually easier and more cost-effective to concentrate the

metals in a small volume of water and batch-treat them. Most manufacturers opt to send the resulting filtercake to a recycling facility that is specifically designed and equipped to efficiently perform the recovery operations.

## One Step at a Time

A team of managers at OLP knew that recovering copper from their operations would consume a healthy portion of electricity daily, require a large "footprint" in floor space (where space is at a premium) and would be labor-intensive. They began looking at other ways to cut production costs and be environmentally proactive at the same time. They considered the company's use of city water from every angle: The quality of incoming water and its effect on their operations, cost, amount used, and the amount being sent to the city sewer after processing.

Regarding the quality of water supplied by the city of Anaheim, Abdul Jaber, safety and environmental engineer, at QLP, states that "The total dissolved solids (TDS) are very high in the water here."

Dr. Valentina Perakh, QLP's wet process engineer, explains further: "The water is so hard that it fosters the precipitation of carbonates, especially a problem on our photoresist



How copper-clad laminate & "Mass Lam" are made: At QLP, the manufacturing process begins on a state-of-the-art treater with the latest instrumentation and controllers. To insure high yield and repeatability, reactivity and melt viscosity are monitored with sophisticated rheological testing equipment. This results in tighter thickness tolerances for controlled impedance applications, improved dimensional stability and uniform thickness.







Second stage, making laminate: The prepreg and copper are laid up in a package in anodized aluminum lamination plates.

line," she says. "It can cause the pipes to plug up."

The hardness of the water is a problem," agrees Abdul. "Our black oxide line operates at a higher pH. Even when we expanded the pipes, they still had a tendency to clog."

The team decided that using deionized water would eliminate some problems and improve the quality of their products, but they wanted to do more than just treat incoming waterthey wanted to reduce the amount used by deionizing and recirculating water to specific tanks. They also wanted to build on their successes in a step-by-step program. With that in mind, they set about in the traditional way of getting bids from at least three suppliers—all the time including in their criteria looking for a supplier who would, in effect, become part of their team and work with them in achieving their goals. With the selection of Hydromatix, Inc., the team was completed and has been working together for nearly two years. The fourth team member is Juzer Jangbarwala, president of Hydromatix, who is a chemical engineer with about 10 years' experience specifically in the finishing industry.

According to Bob Keally, materials manager at QLP, "We targeted our inorganic rinses from our etching, oxide and cleaning lines as the best place to start. Our original goal was to reuse 50 percent of our rinsewater from these areas, but because our parent company, AMP, always promotes the environment-going beyond minimal requirements when it is economically feasible-we strived to go farther. After we analyzed our chemical flows, did the math and came up with a rough matrix of what we'd like to see, we made an internal decision to go for 60 percent."

"That's right," adds Valentina. "Our Phase I goal was 60 percent and we're now actually at 68 percent of reuse of our rinsewater."

The original requirement for the ion exchange equipment size was 30 gpm. When Juzer analyzed the water, however, the high level of contamination required that the system's size be increased to avoid frequent cleaning cycles. Additionally, because the scheme was to ultimately include the photoresist-bearing streams, some capacity had to be reserved for the loading from those streams. The result was an 80-gpm system. the higher flow through the rinse stations keeps the dissolved solids level very low.

"This gives QLP much better rinsing, resulting in higher product quality," says Juzer. "That's one of the salient features of a recycling system. Because the water is recirculating in a loop and not going to the sewer, flow



The copper-clad laminate is pressed and cured for 45 minutes at 345 °F at 80 psi under a vacuum to remove any volatiles and cure the resins. These low lamination pressures result in excellent dimensional stability.



Mass Lam process, material preparation—The surface of the copper-clad laminate undergoes a chemical cleaning process that consists of a 15–20 percent sulfuric acid cleaner and a caustic-based alkaline cleaner. The clean room visible at the end of this line is where the dry film resist is applied.



Dry film—This is a two-step process of laminating photo-imageable dry film resist to copper-clad laminate and then exposing the circuitry pattern.



Oxidation—The black oxide process grows an oxide coating on the copper circuitry to increase surface area to enhance the bonding of materials. The process takes place in a series of tanks that use alkaline caustic-based cleaners, a sulfuric acid/hydrogen peroxide mixture, and a caustic-sodabased oxide and oxide reducer.

rates (within reason) can be increased to desired levels."

Etching, oxide and cleaning operations generate the inorganic rinses. In the cleaning line, a mild acid cleaner is used. The goal is to clean the surface-not remove any copper. More than 5,000 innerlayers are processed each day. The bath dumps and heavy stagnant drag-out rinses are sent to a 1000-gal tank for batch treatment. In continuous production, the recycling system operates 24 hours a day, seven days a week. It is equipped with a modem that gives real-time, on-line data to Hydromatix engineers, if problems have to be diagnosed and corrected. The cleaning cycle of the ion exchange equipment ("regeneration" equipment) generates approximately 600 gal of waste after recycling close to 60-80,000 gal. A reduction in water usage of more than 99 percent.

Simply stated, with the system in place on the inorganic rinses line, QLP has decreased its water usage from 160,000 gal/day to 51,000 gal/ day. It is anticipated that water usage can drop to 4,000 gal/day when the photoresist-bearing rinses are integrated into the treatment/recovery system

Abdul adds that there's another advantage to its new system besides water savings: "Our quality has improved by using deionized water, and it's an innovative idea to use backwash water. Another plus is that the recycling system uses very little water to clean itself, requiring small batch treatment units."



Develop/etch/strip—This is a three-step process. The first chambers utilize potassium carbonate to develop off the unexposed resist. The second chambers etch off the exposed copper with cupric chloride. The third chamber section then strips the remaining dry film resist, utilizing causticsoda-based chemistry.

Planning for Phase II

With the first bridge to zero discharge completed, QLP is taking aim at the next phase. "We're comparing efficiency data of methods to recycle the rinses from developer/stripper machines," says Juzer. A continuousduty clarification system and a batch treatment system have already been installed. These systems are being used to remove photoresist from developer/stripper rinses and dumps, respectively. Removing the photoresist eliminates the plugging of pipes at QLP. The effluent is being studied for feasibility of recycle through the ion exchange system.

In addition, the team is piloting a crossflow membrane filtration system for comparison. Tests will continue for about four more months before the next phase is implemented. (The schematic gives an overall view of the



Flow schematic of water use at QLP Laminates.