

Global Photovoltaic Business Magazine

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COVER STORY

GLOBAL PV INDUSTRY 2009 AND BEYOND

ALTHOUGH THE SOLAR PV INDUSTRY GREW SIGNIFICANTLY IN 2007 AND 2008, A NUMBER OF FACTORS HAVE LED TO A PERIOD OF NEGATIVE GROWTH AT THE BEGINNING OF 2009. IN THE MEDIUM TO LONG TERM, HOWEVER, PROSPECTS FOR THE SOLAR INDUSTRY ARE MORE POSITIVE.

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Upper view of an 1800 MT on-site installation

The Lifeblood of Wafer Manufacturing

How effective slurry reprocessing can improve quality and control costs.

BY SCOTT T. MASSIE



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Photo by CRS Reprocessing Services

Photo by CRS Reprocessing Services



Slurry Tank Farm

The Market Erosion

During the last six months, the PV industry has had to endure an exceptional amount of volatility. In the context of the larger global recession, the impact of a depressed market is everywhere. Governments, under the strain of the battered economy, have slashed subsidies for solar industry expansion. The collapse of Spain's photovoltaic sector, in a country that accounted for over 40% of the world's solar energy in 2008,¹⁾ has been well documented. Bloomberg reported in June 2009 that Germany's feed-in tariffs, which had built the solar industry up to US\$8.8 billion in sales, were being reduced.²⁾

The effects of such tumult are many. We've seen a significant decrease in PV module demand along with oversupply in the entire PV supply chain. The effect of this oversupply has already been seen in the price of finished silicon wafers, which have dropped by more 50% in 2009. All of these factors have led to significant market erosion that may ultimately lead to substantial fallout. Industry-wide, margins are getting tighter and are not expected to increase dramatically anytime soon.

Cost Reduction Is Required

Analysts indicate that manufacturers expecting to endure this crisis will have to make meaningful and significant cost reductions. In any business, cost efficiencies are important. In the current environment, operating efficiently and reducing costs wherever possible may be the difference between survival and closed doors.

One area that solar wafer manufacturers can look to help contain costs is their slurry reprocessing operations. Slurry is at the heart of wafer manufacturing, where it is used to cut the wafers out of silicon ingots. Slurry is one of the factors that help ensure precise cuts that conform to extremely tight tolerances, and is composed of Silicon Carbide (SiC) and a carrier such as Polyethylene Glycol (PEG) or oil. Fed along a guide wire, the abrasive silicon carbide in the slurry (the "grit") cuts

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through the ingots to produce the wafers. To keep the number and quality of the wafers high while maintaining acceptable unit cost, slurry must be reprocessed.

Slurry Reprocessing Cost

Not only is slurry important to the process, it's also a significant production cost. Often it's second only to the raw material silicon, itself a big number. Prices fluctuate, but at a market price of US\$3.50 per kilogram, a customer with 10 wire saws could spend up to US\$16 million a year for the silicon carbide slurry alone, not including disposal fees or labor. For the vast majority of manufacturers, slurry reprocessing ranks in the top five operating costs. Optimizing this aspect of the business can have dramatic, and, more important, lasting effects on wafer production costs and overall quality.

For wafer manufacturers that are not currently reprocessing, instituting a slurry reprocessing program or starting day-one in a greenfield operation are among the most significant margin-enhancing improvements that can be implemented. For a wafering operation running 10 wire saws with a volume of 385 metric tons per month, slurry reprocessing can result in a savings of US\$8-10 million per year, net of recycling costs, utilities, and infrastructure investment.

The Importance of Recovery Rate

There are several different ways to reprocess slurry to produce a good cutting medium and leave behind the unnecessary materials such as kerf particles. A fairly robust and straightforward process that doesn't involve chemical components is to run the fluid through several centrifuging steps followed by filtration or distillation. This allows for the separation of large particles that are still viable cutting materials from small particles that are no longer effective. The recovered material is then recombined with a minimal portion of virgin material to replace the portion that has been eliminated.

This is why recovery rate becomes an

important criterion for evaluating slurry reprocessing options. Recovery rates can vary due to individual processes and providers. As an example, at CRS Reprocessing Services, it is able to recover between 80% and 90% of both the grit and the carrier. The actual amount of recovery is a function of the wafer size, wafer thickness, saw set up and the Si kerf loading in the used slurry. For oil-based slurries, the recovery of the cleaning solvents used to rinse wafers and equipment is typically greater than 90%. In short, the higher the recovery rate, the more material is effectively recovered and reused, and the less that must be spent on new material.

Another Critical Factor: Slurry Quality

As important as recovery rate is when considering the economic impact of slurry reprocessing, it's not the only factor. Equally important is the quality of the slurry. There's a temptation to consider slurry a commodity product, but its impact on the quality of PV wafers is significant. All slurries are not made the same, and there is a true art that complements the science of fashioning the ideal slurry formula for each application. This requires a great deal of emphasis on quality, through testing and certification, to ensure each batch of slurry is conforming to tightly defined specifications. Whether it's particle size distribution, density, viscosity or water levels, the value of consistency cannot be overestimated. Once achieved, consistent output of these parameters is critical to maximizing the opportunity of every cut and helping to reduce waste and improve productivity.

Consider the financial impact if poor slurry leads to unusable wafers. Assuming 10 wire saws and a cycle time between cutting and inspection of three cuts, 30 cuts worth of material could be wasted before detecting a problem. At US\$4,500 to US\$5,000 per cut, one incident could cost over US\$135,000 alone. The compounded effect of lost time, materials and opportunity quickly amounts to significant costs.

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4 Options for Slurry Reprocessing

In general, there are four options when it comes to reprocessing slurry: do-it-yourself; off-site reprocessing; on-site reprocessing; or to do no reprocessing at all. This last one, where the used slurry is simply discarded and virgin slurry is introduced, is extremely expensive and becomes practically untenable in the current environment.

Do-it-yourself

Some manufacturers are pursuing the do-it-yourself route to recycling the slurry. By taking the process in-house, they assume the responsibility for this aspect of production. Several vendors exist that can provide carrier recovery systems, centrifuges and other equipment for reprocessing. The trade-off, of course, is that additional labor will be required to run the systems as well as the technical expertise to ensure that the slurry is properly formulated and optimized for the process.

The downside is that do-it-yourself options tend to have much lower recovery rates for both grit and for the carrier. These processes typically recover only a small portion, say, 20%-30%, of the carrier. In addition, a do-it-yourself scenario may impact quality control and productivity resulting from lower specifications, limited lab verification tools and increased downtime.

To put it in perspective, an optimal reprocessing solution that increased the recovery of both grit and carrier could easily decrease the overall costs for a 10-wire-saw operation by US\$275,000 to US\$375,000 a month. These factors, along with the need to fund resources that are not central to the business, reduce the potential savings that are expected by taking the process in-house.

Off-site Reprocessing

Off-site reprocessing, where a vendor picks up the used slurry from the manufacturer and takes it to a distant site to conduct the reprocessing, has a number of benefits. Chief among them is eliminating the capital expenses of a physical structure required for the reprocessing and shifting the overhead costs to an outside reprocessing provider. The service fee for off-site repro-

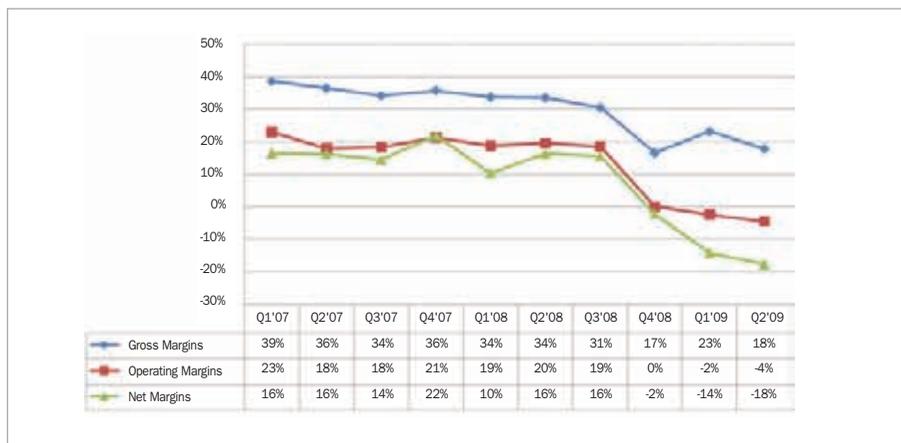


Figure 1. PV supply chain margins (Source: PVSociety.com, "PV Revenues Rebound but Margins Fall", Aaron Hand, 9/24/2009)

Photo by CRS Reprocessing Services



On-site monitoring

cessing can be competitive, perhaps even lower than a common alternative, on-site reprocessing. There are a number of other costs, however, that factor into an off-site processing scenario that should be considered.

Chief among them are freight costs, both trucking and shipping, which can vary depending on the amount and distance the slurry needs to be transported. In some cases, the expense can be considerable. Rates range from 3 cents per kilogram within a country up to 40 cents per kilogram around the world. For a customer processing 800 MT per month, this could total over US\$200,000 per month. Off-site reprocessing also requires that a manufacturer have large amounts of slurry “in play”. The time to transport the slurry to

the reprocessor, undergo reprocessing and then return it to the manufacturer can take anywhere from three to six months. During that time, additional slurry must be used to continue operation, adding a working capital expense to the balance sheet.

There are also higher capital and labor costs to be considered in the off-site option. In some cases, off-site reprocessed slurry is separated to its core elements of grit and carrier. When that material is returned to the manufacturer, it must then be re-blended and checked to ensure proper levels of components. This requires having skilled staff and facilities on hand to ensure the appropriate quality standard is maintained.

Finally, there are the governmental regulations that apply to transporting this kind

of material over long distances. These vary from country to country, but oil-based carriers in particular are considered hazardous materials in many countries including the U.S. and most of Western Europe. Any time a product of this nature is transported, the potential exists for accidents and spills to occur, as well as the direct and indirect costs associated with an incident that negatively impacts the environment.

On-site Reprocessing

For many manufacturers, on-site reprocessing where the reprocessing is outsourced to a provider who designs, builds, and operates the reprocessing facility on the same property as the manufacturer is a more viable solution. Because on-site reprocessing takes place within close proximity of the manufacturing, the significant cost of transportation is eliminated. Equally significant is the amount of slurry that must be on hand is reduced. In a typical on-site scenario, a batch of slurry may need only three to five days to reprocess. This allows manufacturers to operate much leaner and carry less operating expense day to day.

From a quality control standpoint, on-site reprocessing brings full transparency to the manufacturer who has the advantage of immediate and verifiable slurry. Since the slurry does not leave the facility, it is reprocessed in a closed loop that eliminates the risk of outside contaminants entering the production stream. On-site testing, conducted by experts who can easily and quickly adjust levels to achieve consistent and optimized slurry, helps ensure wafer yields are high with minimal waste. These types of attributes get to some of the less tangible, but no less important, benefits of on-site reprocessing. By having highly experienced staff on hand, quality is immediate and at its peak. Better quality and higher yields, combined with operating best practices, translate to significant savings and a more fortified market position in the long term.

For many manufacturers, a turnkey on-site solution provides a high level of assurance that the slurry will perform optimally and contribute to operating and production efficiencies. The benefit is that it allows PV wafer manufacturers to continue focusing on their core business.

In the current environment, any chance to reduce costs and improve quality is a welcome opportunity. 

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PROTECTING THE ENVIRONMENT IS THE NATURE OF OUR BUSINESS



CRS is committed to preserving the environment as evidenced through every facet of our operation. Our primary line of business is to convert waste fluids into a reusable product while simultaneously reducing waste disposal. Our on-site business model reduces the risk of material spillage or emission by limiting the transportation of such materials, and we directly support the solar industry whose energy is a renewable resource.

Our proprietary separation processes are mechanical in nature and do not use any harsh chemicals that could potentially endanger the environment. At CRS, we continue to seek new and innovative ways to fulfill our role as global stewards in an ongoing effort to protect and serve the communities in which we live and work.



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Our environmentally friendly process does not use chemicals, and recovers up to 85% PEG and SiC. This eco-conscious approach greatly reduces waste and hazardous materials while also lowering CO₂ emissions by minimizing transportation requirements.

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For more information, visit www.crs-reprocessing.com/slurry.

