Photovoltaic Industry Growth Updates: High Purity Water Risk Management Through Standardization

By Betty Pennington, UPW Specialist

This is an exciting time for the Photovoltaic Industry, as momentum builds and growth opportunities expand with new solar products. Many challenges have been revealed during this rapid growth period, one of which has been the need for better risk management through standardization.

PV Industry Special Concerns:

Because the industry has grown rapidly in many different directions, without adequate standards in place, a reduction in quality has been identified. As the PV industry strives for low production costs and high process yields to maintain a competitive edge, contamination issues have raised new concerns. Systems are implemented based primarily on cost, sometimes without adequate consideration to the potential negative impact of improper material selection and/or contamination levels. As a result, yields may suffer due to the lack of quality and consistency. Less costly materials/designs must be carefully managed against the offset from yield losses due to elevated contamination levels.

To minimize contamination levels and reduce quality fluctuations, the need for standardization has been recognized and knowledge/lessons learned from the semiconductor industry are being adopted. Equipment suppliers, system designers and installers must work together to meet minimum standards in order to maintain quality levels with their products. The facilities area moved in a positive direction recently by approving the new SEMI F63-0309 Guideline for standardizing the high purity water quality used for wafer production and cleaning.

Standardization Development Process:

Since water quality requirements are not currently assumed to be as stringent as in the semiconductor industry, a task force was formed to identify specific needs and develop a relevant high purity water guideline for PV. The task force methodology included a member survey to obtain benchmarking information. A literature survey and direct communication with PV industry experts was also utilized. A “no harm” guideline approach was used and an existing semiconductor Guideline F63 was ultimately modified to use for PV industry guideline.

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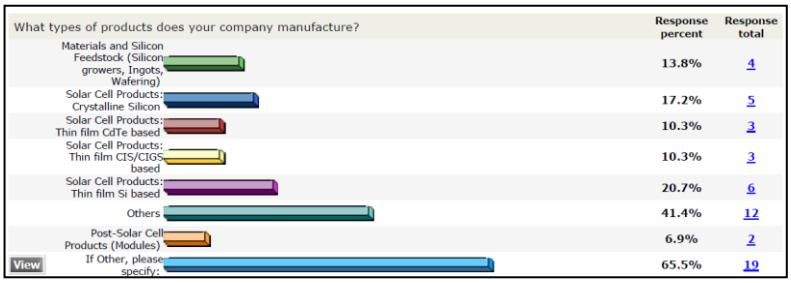
Balazs NanoAnalysis has an extensive background with UPW Guideline development and was an active task force member for this PV guideline as well.



Industry Survey Results:

As suspected, industry survey results regarding the water system designs and water quality produced were quite varied. Most were recirculating systems and ranged in sizes from <50 gpm to >300 gpm. It appeared that some of the locations had a history of semiconductor manufacturing. Although lower resistivity values were deemed acceptable, most systems included RO and DI bed design. Tight particle control was in place as many locations used microfiltration or ultrafiltration as final process step. Piping materials included PVDF, PFA, SS, PVC, CPVC, and PP.

Higher than expected resistivity levels were reported (>17.5 Mohm) and lower sensitivities to dissolved organics were indicated (<20 ppb) . Some sites required tight controls for bacteria (<10/L) and particles (<1000 @ 0.1 um) but dissolved and total silica levels were relaxed (<20 ppb). Particles and resulting pin holes are considered critical when visible from ~0.5 um. Sensitivities to iron, copper and aluminum had an observed impact on yield and efficiency but were still orders of magnitude higher than semiconductor requirements (<1 ppb). Anions reported were chloride, nitrite and sulfate (<1 ppb) but dissolved oxygen, boron and temperature control limits were not required at this time. Because of the wide range of products being manufactured in PV, a two-tiered approach to water quality specifications was implemented. In the future, water quality requirements are expected to tighten as raw materials become cleaner and processes become more sophisticated.

The Need to Establish Specifications from Guidelines:

High Purity water (HPW) guidelines are a tool for facilities managers and process engineers to ensure that the supply is consistent and does not negatively impact the final product. Specifications are defined as water quality requirements. They are or should be process specific. Guidelines are defined as a starting place for discussion and are meant to be modified, where appropriate, by the end user. Historically, UPW guidelines and specifications have been established using a number of different protocols. This includes back calculation from levels effecting wafer yield (limited) or by facilities with SPC to show that UPW production is under control (most common). Companies will be utilizing the new SEMI F63-0309 guideline to develop site specific specifications based on their particular application needs.

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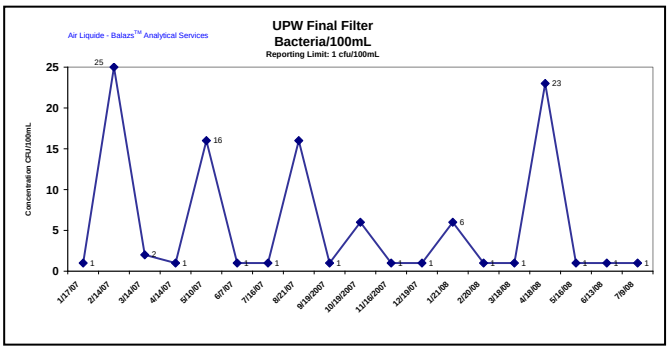
Monitoring the POD location assures the customer that the water plant is operating correctly and high purity water is consistently discharged. In addition to the POD, many supporting locations are also monitored within the purification system to ensure quality compliance. Monitoring the incoming water, major water system components and the return water to the plant is important to detect quality changes before they negatively impact the POD. By achieving stable water quality at the point-of-distribution (POD), yield efficiency can increase.

It is also important to note that critical decisions should not be based on a single data point. Instead, a database should be studied to better understand the normal range of quality variation over time. Compiling accurate data through proper sample collection and analytical methods, along with developing a long term monitoring strategy will also help ensure process stability.



Quality Control to Boost the Bottom Line

Incorporating a balanced analytical monitoring program, will ensure facilities process control and safeguard product yields. Managing costs while considering contamination risks will also enhance yield recoveries and allow an emerging industry to continue to flourish.

As the PV industry moves toward the future, it has become clear that process engineers, facilities, analytical lab, and equipment manufacturer personnel will need to continue to work together to effectively address and solve the many challenges arising from a deficiency in standardization. The industry will continue to work towards better understanding water quality at the wafer point-of-use and how it impacts yield and Balazs NanoAnalysis will continue to help customers identify and resolve process needs. By bringing all these considerations together, the industry will be in a better position to establish new standards and improve existing ones.

For additional information, please contact us.

Credit: High Purity Water Needs for the PV Industry – Part 1: Development of Cost Effective Specification John Morgan, Sarah Schoen, Andreas Neuber, Slava Libman, Ultrapure Water Micro Conference, Nov. 4, 2009