

COMPANY VISION

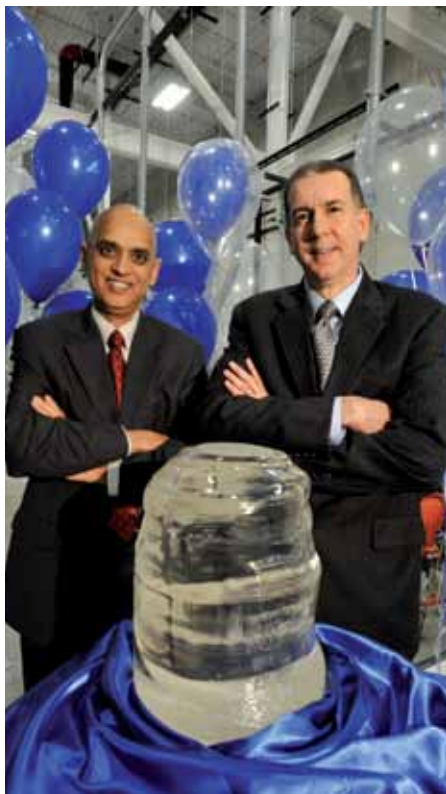
Rubicon strives to fill the capacity gap



Raja Parvez, chief-executive officer of Rubicon Technology, Inc., talks about how his company is playing a pivotal role in scaling the LED industry by supplying 6-inch diameter and larger substrates.

Yole Développement: What are the advantages and risks for Rubicon of pioneering large substrates?

Raja Parvez: Rubicon has become the de facto standard for 6-inch. We have more than 80 percent market share in 6-inch LED products. We announced the largest sapphire agreement between any major electronics company and any sapphire producer, exclusively for 6-inch, running from November 2010 to December 2011 and worth \$72 million. We are working with many major electronics and LED chip manufacturers around the globe. In some cases they are at an R&D stage, some in qualification processes, some in low volume manufacturing. I'm right now speaking to you from Asia. Today, I've been to a major customer here and we discussed a pretty good volume of 6-inch wafers in 2011 for them, and they are one of the major, leading electronics and LED chip companies. I believe the risk is minimal because a great number of manufacturers have already decided to migrate to larger diameters.



Expanded substrate capacity: Rubicon Technology, Inc. executives Raja Parvez, President and CEO (left), and William Weissman, CFO (right), celebrate the first sapphire boule from the company's recently-opened Batavia, IL facility (Courtesy of Business Wire)

YD: When will companies move to using 6-inch substrates?

RP: One major electronics manufacturer has already moved to high volume production since Q2 2010. We have the supply agreement with them. I believe a minimum of two additional manufacturers will go into volume production, maybe in the second half of next year, maybe sooner, but that's a very conservative view. Volume production means minimum using 5000 6-inch wafers per month. There may be other manufacturers who move to 500, 1000, 1500 wafers per month.

YD: And what's the timeline for 8-inch adoption?

RP: We are already providing samples to chip companies and working with MOCVD reactor manufacturers. Many LED companies are either optoelectronics or semiconductor companies. Those industries have already moved to larger diameters, so their back-end equipment has 8-inch and 12-inch available. So, companies want 8-inch production because it is more cost effective and re-utilises the current infrastructure available to them. Perhaps you will see more focus on 8-inch in the later part of 2011, but I believe that production is going to happen sometime in 2012 and after.

YD: How do you help companies move to larger substrates?

RP: Through specification alignment and participation in customer design-of-experiments for process optimization. Many of our engineers are from the optoelectronics and semiconductor industries. Since we have this experience, and work with many LED chip companies, we can reduce the cycle time at the R&D level and reduce the trial period so they can move to production faster. We are the only vertically integrated company making crystals and polishing them in larger diameter and high volume. This gives us the flexibility to take feedback from the device level, move that to the polished level and to crystal growth.

YD: What challenges are companies facing in moving to larger diameters?

RP: Companies are going through the same challenges as in the move from 2-inch to 4-inch. Remember one thing though - from 2-inch to 4-inch, it took around

three years. For 6-inch, thanks to the MOCVD reactor manufacturers, their equipment is much more optimal and designed for uniform performance. Availability of high quality sapphire in high volume from Rubicon and optimised equipment has enabled them to reduce the challenges.

YD: What are the most important substrate specifications to your customers beyond the diameter, and how are you able to control and influence those?

RP: If the wafer is not flat it becomes like a potato chip during processing, which cannot be processed properly, so the key tolerance for 6-inch and 8-inch is the flatness across the wafer. Thickness is not standardised yet, and is right now anywhere from 1-2 mm, but I believe it will settle closer to 1 mm in the next several months. Surface morphology has to be uniform before depositing the epitaxial layer. Also particulate count on the polished surface is very important.

The last part is stress-free crystals. These wafers go through temperature cycles of up to 1200°C. That causes stress, which can create cracks in the wafers and reduce yield. Rubicon's technology produces almost stress-free crystals. During the crystal growth cycle, 50 percent of the time is taken to grow our crystal, and 50 percent is taken to cool down the crystal. During cooling, stresses are automatically released. Other technologies introduce significant stress, so it's common to put those wafers through an annealing furnace to reduce it, bringing us a huge advantage by comparison. We have shipped close to 70,000 6-inch polished wafers, almost 60% silicon-on-sapphire, 40% LED. If one single wafer had a breakage during manufacturing, I would get a call from the president of that business, because it is so detrimental. So we make extra sure that the wafers are stress-free and flat.

YD: Sapphire substrate prices have increased strongly this year. Now that Rubicon and other companies have put extra capacity in place, how will that change?

RP: There's a lot of hype in the market about additions of capacity. The reality is, still there are a handful of manufacturers who can produce good quality and high volume. Everything else is hype, and that is evidenced by feedback I'm getting from customers. Still there's



Sizing up: Rubicon's ES2 sapphire crystal growth technology has progressed from making 3kg boules suitable for 2-inch wafers to 200kg boules from which wafers larger than 12-inch diameter can be made (Courtesy of Rubicon)

a shortage of sapphire at all different diameters. For 6-inch and 8-inch, since we are the market leader, we have made sure that pricing is consistent and stable. From 2-inch to 4-inch we sell only ingot products to polishing companies, and the pricing has gone up

significantly over the last 12 months. As the market demand continues I believe the pricing will be good for us. Although the rate of increase may not be there that we have seen in the last three quarters, I am not seeing a significant reduction.

YD: Is the market planning for the advance to general illumination adequately to avoid another substrate price increase like we've just seen?

RP: If the market demand continues to increase as expected, I believe that there will be a continuous shortage of sapphire. The rate of increase in 2010 was really significant at all levels, I think the rate of increase in 2011 may be much more stable. If general illumination kicks in, however, it could be a similar situation.

www.rubicon-es2.com



Raja M. Parvez is president and chief executive officer of Rubicon Technology and a member of the board of directors. Prior to Rubicon, Mr. Parvez served as chief operating officer, chief manufacturing officer and vice president at CyOptics, Inc., a designer, developer and marketer of optical components for the broadband industry. Previously, he served as president and vice president of manufacturing at Optigain and was distinguished and consulting member of the technical staff at Lucent Technologies with a focus on operational excellence for Lucent-Optoelectronics products.

LED ManTech

Significant improvement in LED fundamental and manufacturing technologies needed for massive adoption in general lighting

MARKET TRENDS

... "The packaged LED market is experiencing tremendous growth with an expected CAGR of 28.2% between 2009 and 2015. Growth will be driven by large LCD backlight applications through 2013-2014. However in order to successfully transition to general lighting applications, significant technology and manufacturing efficiency improvements are still needed in order to reduce the cost per lumen of packaged LED," says Eric Virey, Principle Senior Analyst, LED.

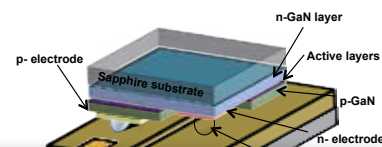
KEY FEATURES

This report, co-branded by EPIC and Yole Développement, provides a complete vision of the established and emerging front-end and back-end technologies for LED manufacturing. It also provides updated volume and \$\$ forecast for packaged LED, split by application with capacity analysis and price trends.

CONTACT US

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GaN LED Chip Design Overview (1):



Thermal Management: High Power LEDs

