LUMINUS
LEADER IN BIG CHIP LEDS

Luminus goes large on packaging

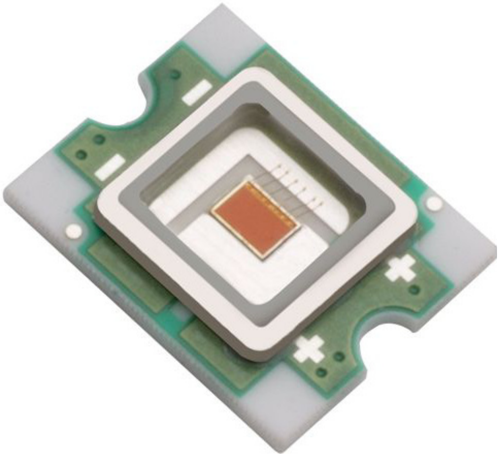
Paul Panaccione, Director of Packaging Technology, and Arvind Baliga, Vice-President Engineering, at Luminus Devices, talk about how their company integrates the industry's biggest LED chips into suitable formats for their customers' applications.

Arvind Baliga, Vice-President of Engineering, Luminus Devices

Paul Panaccione, Director of Packaging Technology, Luminus Devices

Yole Devéloppement: Luminus Devices is renowned for its big, photonic lattice, LED chips. What are the challenges in packaging them?

Paul Panaccione: Photonic lattice efficiently extracts light from the chip surface, and also collimates the light. It directs the light perpendicular to the chip's surface, rather than in a Lambertian shape. We don't want to alter the shape of that light emission. The photonic lattice is designed to emit into air, it's matched with the refractive index of air closely, and so we use an air cavity package. We use a glass window in the package for protection, so we need to make sure that doesn't alter the collimated light using anti-reflective coatings. Then, our chip area is much larger than any other LEDs out there. From a packaging perspective they resemble power ICs or power transistors, even microprocessors. Some of our devices are close to 100 W input power, so we're dissipating 80 W or so of heat. The challenges with big chip are primarily thermal. We address that with materials and package design that may be unconventional in terms of LED package design. Another concern with big chip is CTE matching to the package, so we've done a lot of work on matching materials and finding a compliant interface between the chip and the package. In addition, our devices emit a lot of light, 15 W or so, and we have to make sure the package can handle that.



One size fits all: For projection applications like those its Luminus Devices can tailor LED chip sizes of products like its SBT-16 LEDs to the shape of customers' microdisplays without needing to change the package. (Courtesy of Luminus Devices)

YD: To what degree are you able to meet these challenges with commercially-available packaging materials?

PP: We've had to work very closely with our suppliers on developing new materials. We've formed partnerships with our key suppliers where we share roadmaps and challenges. As a result we've actually developed a few new or improved materials. It has taken a while – a lot of work and a lot of co-operation – but it's resulted in some pretty innovative and successful material development.

YD: Are there any examples that you can talk about?

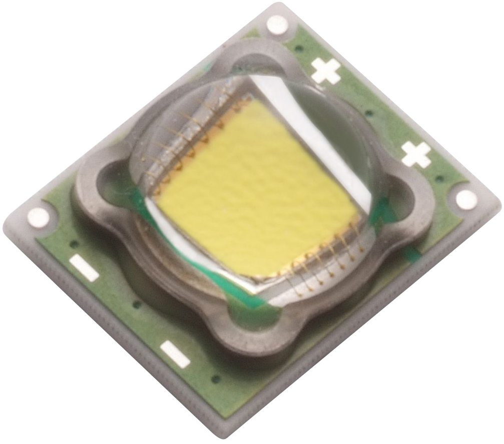
PP: We've worked very closely with our die-attach supplier in developing a higher thermal conductivity, lower modulus material that will both give us better thermal conductivity and accommodate the thermal mismatch between chip and package much better. We've been running that material in our product for a couple of years now with very high reliability. On our packaged substrate itself, we need a dielectric material in our package to separate electrical traces but that also happens to fall within the thermal path in some cases. We've worked on developing high-thermal conductivity dielectric material that has enabled higher brightness.

YD: What are the key packaging material areas that you're focusing on where more improvement is still needed?

PP: Thermal always comes to mind first for me, because these are such high power devices. Right now we are working with one of our thermal interface material suppliers and actually developing a material that has an order of magnitude higher thermal conductivity than what we're currently using. That's going to allow us to drive the chips at even higher brightness, reduce thermal roll-over and allow higher drive currents. As a result we're going to be looking at a 20 per cent or so boost in brightness. We're going to be coming out with that in the next six to nine months.

YD: How does application influence package design?

Arvind Baliga: One way to look at the package is that it's the interface to the application. It's the thermal, optical and electrical interface. We work



Photonic lattice: Luminus Devices' photonic lattice technology efficiently extracts light from the LED chip, creating a collimated beam when emitting into air, or a Lambertian distribution when encapsulated, for example in this warm white SST-50 package. (Courtesy of Luminus Devices)

very closely with our customers to understand the application, because in doing so we define the package. We also work very closely with our vendors and suppliers to make sure we understand their technologies. We pair those technologies with the customer's needs in the application. A good example is projection, where we design our chips to match the size of the microdisplay. The package is designed so we can easily customise it, we can easily attach chips with different sizes and aspect ratios. We don't have to go about retooling the line or changing the package. The same package can meet the need for multiple customers. So, our operations benefit from that because they're building off of the same platform and our customers are happy because they see the customisation.

YD: How much further do materials need to go to get LEDs to where they need to be for solid state lighting to really penetrate?

AB: In all of the thermal issues the industry has made a lot of progress. It's of concern, but a well-designed product today should be able to meet the requirements. It may be more of a cost challenge. The focus on cost is what will increase penetration. I think it's inevitable that overall there will be penetration over the next few years.

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Arvind Baliga, Vice-President of Engineering, Luminus Devices
He joined the company in May 2005. Dr. Baliga has extensive product development experience spanning components, subsystems and instruments in the telecom and industrial process control markets.
Dr. Baliga worked on the development of 980 nm pump chips at Lasertron and subsequently as Director of Engineering and Program Manager led tunable transmitter development at Nortel Networks (Coretek). Most recently, Dr. Baliga was Director of Engineering Programs at Axsun Technologies where he led the development of an award-winning micro-spectrometer product line. Dr. Baliga holds a Ph.D. in Electrical Engineering from the University of Massachusetts at Amherst.

Paul Panaccione, Director of Packaging Technology, Luminus Devices in Billerica Massachusetts
He has led the design and development, as well as the initial assembly production launch of their high power opto-electronic packaging platforms supporting the world's largest and most powerful LEDs. Prior to joining Luminus, Paul's experience includes managing RF packaging at IBM, Anadigics and Alpha Industries; 3D stacked memory packaging at Viking-Interworks/Sanmina-SCI; and contract manufacturing at Hana Semiconductor in Bangkok. Paul holds a Bachelor of Science in Mechanical Engineering Technology from Johnson & Wales University, and is a member of IEEE/CPMT, SMTA and IMAPS. He has several technical publications to his credit and holds nine patents related to microelectronics packaging.