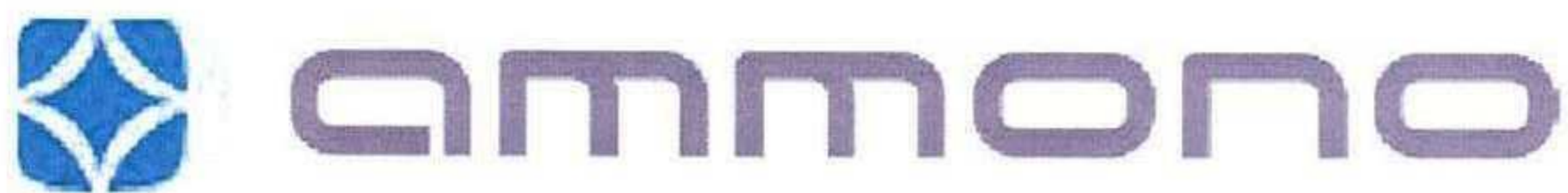


Substrates & Materials Award

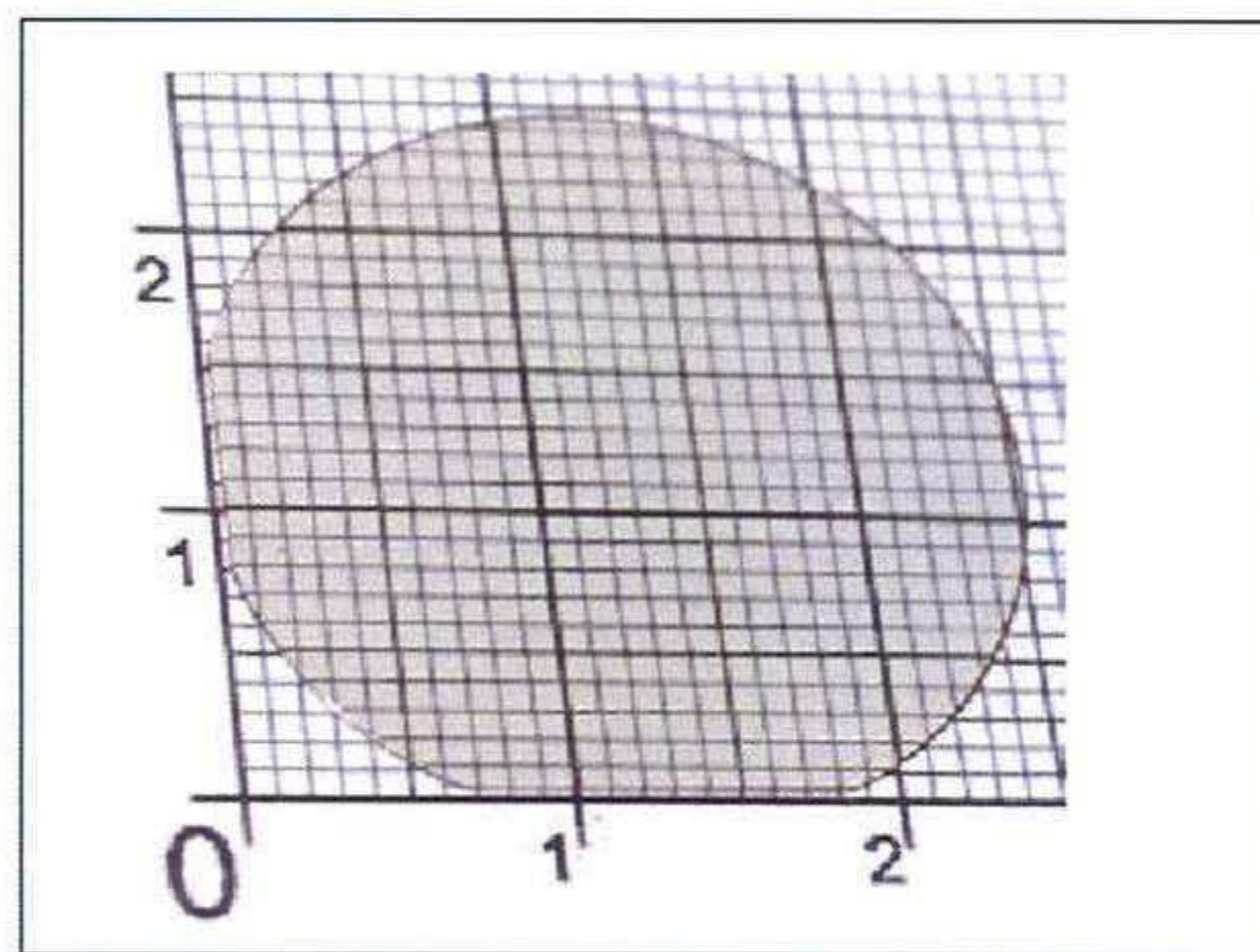


High-transparency n-type substrates

Today's LED industry is at a very important turning point where the market imposes new product segmentation leading to new technological requirements in the production process.

Up till now within the main LED market segment - residential lighting, the challenge was to bring down the cost of a single lumen of light. This cost was the main barrier to entry while competing with other light sources. Today, new market segments related to the ultra-high brightness have LEDs appeared. The first one is street lighting where LEDs have the advantage of a much higher reliability than existing solutions. LEDs for automotive head-lights is another application. The added value is lower power consumption / light output ratio than in the case of standard head lights. Additionally LEDs for the backlight in outdoor infotainment displays where a perfect display readability in daylight conditions are needed. For those applications the cost of a lumen is still important, however much higher light output and good heat dissipation are of ultimate importance. The CS award winning High Transparency n-type gallium nitride substrate introduced by Ammono is the result of a clear market need for high quality GaN substrates aiming at ultra-high brightness LEDs.

Ammono's substrate brings together two key features. The most important one is the inherent low dislocation density of the ammonothermal GaN. In AMMONO-GaN this parameter is at the level of 10^4 cm^{-2} , which is an order of magnitude, or in some cases even two orders of magnitude lower than for other technologies used to manufacture gallium nitride. It provides two direct benefits. The reduction of the droop effect which means better efficiency in the case of high light output and a



better heat dissipation which influences the working conditions of the LED and increases its life-time. The second differentiator is the substrate's high transparency which improves the light output of the LED. For years ammonothermal gallium nitride production method was considered as the one where it was impossible to obtain highly transparent GaN crystals. Breakthroughs by Ammono during the last few years allowed for the engineering of a new class of substrates with high transparency.

As a result the LED industry has a substrate paving the way towards three important breakthroughs. Those are: the decrease of the cost of a single lumen, the increase of the LED life-time and a much higher light output.

"Our product defines a new class of gallium nitride substrates"- explains Piotr Wilinski, the sales and marketing director of Ammono. "Today, we are the only ones to provide gallium nitride mono-crystal substrates with homogeneous parameters over the whole wafer. As the result the crystal lattice in our wafers is much more flat than in the case of wafers obtained by using other manufacturing technologies. It enables a higher manufacturing yield which is very attractive for the mass production. If we add to it the advantages

of the High Transparency n-type substrates the customer obtains a perfect solution to address new market segments. We are conscious that this is just a beginning of a road aiming at introducing AMMONO-GaN substrates to new LED market segments. Working closely together with leading LED manufacturers world-wide we are actively improving further the characteristics of our substrates. Our competitor's HVPE-GaN which was tested by many of our customers have made the LED industry very careful in considering GaN as a substrate. The opinions that we get is that the cost-performance benefit of HVPE-GaN based LEDs is not obvious. The answer to it is the High Transparency AMMONO-GaN which boosts the LED performance and allows new market segments to be addressed."

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Richard Stevenson, Editor, comments:

"Ammono's growth technique is a wonderfully elegant way to address the challenging problem of how to form GaN substrates. The tremendously flat, ultra-high-quality substrates that result should help to spur further improvements in laser and LED performance."

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