

**Colorless Sapphire
is Indispensable**
for Lower Wafer Cost
and Higher LED Brightness

Synthetic sapphire wafer is the basic component for LED production.

Within the last 10 years LED manufacturing has increased by a factor of 40, while sapphire wafer consumption has exceeded a hundred million pieces per year. Needless to say, sapphire wafer makers and LED manufacturers are focused on cost management. Taking into consideration today's high volume production, even minor variability in key sapphire parameters may have significant influence on wafer makers and LED manufacturers' cost management.

LED makers pay particular attention to LED brightness reproducibility in their manufacturing process. One of the main reasons for LED quality deviation is the presence of sapphire wafers with color alteration within a batch processed in an MOCVD. Color alteration is caused by fluctuation in sapphire growing technology or excess impurities in grown sapphire and can be revealed in a sapphire crystal after growing, during wafer manufacturing, or under UV exposure.

In this case sapphire wafer manufacturers have to perform an additional annealing to recover sapphire transparency. This operation leads to production cost increases of up to 20 cents per wafer and an increase to the production cycle.

These negative effects are mitigated by using colorless sapphire, which consistently retains its color parameters during the entire manufacturing process and under UV-exposure. If, for example, a company produces 200,000 4" wafers per month, it can save up to \$500,000 per year by eliminating the annealing.

For LED makers, the risks of using colored wafers can be significantly higher. Color alteration forms light absorption centers. These centers lead to luminescence parameters variability within an MOCVD, even if there is 1 wafer with abnormal color within a batch, and consequently to lower epitaxial yields. LEDs grown on a colored sapphire wafer demonstrate brightness loss and may become prone to overheating within a device.

Ti, Fe, C impurity content in sapphire is harmful for LED application.

Abnormal concentration of these impurities causes formation of absorption centers in the visible spectrum:

ABNORMAL IMPURITY	HUE OF SAPPHIRE CRYSTAL COLOR	SPECTRUM, NM
TI	● Pink	650~700
C	● Yellow	570~600
FE	● Yellow / ● Brown / ● Blue	570~600

LED makers also benefit from colorless sapphire. It is a cost saving solution. If a wafer with significant color deviation is put into an MOCVD reactor, there is a high risk that the whole production batch will be flawed and the loss of this process could cost \$3000.

Because of dynamic growth of the LED market, coupled with tough competition, LED companies are forced to identify ways to strengthen their competitiveness. Using high quality colorless sapphire is an efficient solution for cost management and product quality improvement.



Monocrystal
4/1 Kulakov pr., Stavropol,
355035, Russia
Phone: +7 (8652) 95 65 29
Fax: +7 (8652) 95 65 28
sales@monocrystal.com
www.monocrystal.com

Changzhou Monocrystal Optoelectronic Co., Ltd.
No.97 Liuyanghe Road, Trina PV industrial Park,
Xinbei District, Changzhou, Jiangsu, China
Phone: +86 519 8519 0522
Fax: +86 519 8519 0511

Monocrystal Co., Ltd.
No.450, Sec 1, Dong Xing Rd, Chubei City,
Hsinchu Country, 30261 Taiwan (R.O.C.)
Phone: +886 3 5506036
Fax: +886 3 5506036

Monocrystal Korea, Ltd.
443-702, D-189, Digital Empire, Blds., 980-3,
Yeongtong-2dong, Yeongtong-gu, Suwon-si,
Gyeonggi-do, Korea
Phone: +82 31 303 4660
Fax: +82 31 303 4661

Monocrystal USA, Inc.
1250 Oakmead Pkwy, Suite 210,
Sunnyvale, CA 94085, USA
Phone: +1 408 451 8470
Fax: +1 408 501 8808

About the authors

Ludmila Zubova is Vice-President Marketing at Monocrystal. She is responsible for Monocrystal's business development and strategic planning.

Eugene Zalozhny is Senior Marketing Manager. He is in charge of the market activities for Monocrystal's sapphire products.

About Monocrystal

Monocrystal, a part of the diversified industrial group of companies Energomera, is a leading supplier of sapphire products for LED and metallization pastes for solar industries.

According to the company's estimates, every 3rd LED and every 10th solar module in the world is made with Monocrystal products. The company's product portfolio includes large diameter sapphire substrates and ingots for LEDs, bricks and ingots for consumer electronics, optical windows, screen printing pastes for silicon wafer solar cells, and conductive silver pastes for automotive glass. The company exports more than 98% of its products to more than 25 countries worldwide. For more information, please visit <http://www.monocrystal.com/>