
comptek
solutions
Best in class passivation
for III-V optoelectronic devices

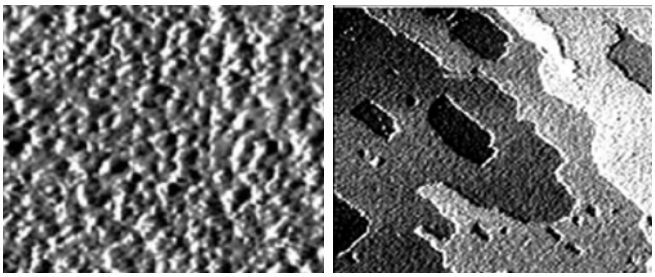
Kontrox™

Oxidation induces harmful atomic-level defects in III-V-based optoelectronic devices leading to poor device performance & power efficiency.

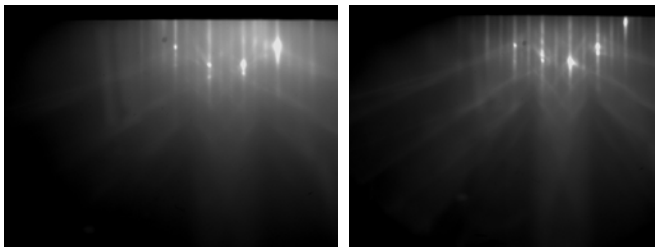
With Kontrox, the oxidation problem is finally solved allowing to redefine the efficiency of the next-generation devices.

For the first time, we control oxidation with our breakthrough technology- Kontrox™. It transforms the surface of the material into high-quality, thermodynamically stable crystalline oxide structures. These structures exhibit unprecedentedly low levels of surface defect states - up to 98% fewer defects than surfaces protected with thin-film deposition techniques (ALD, PECVD).

Kontrox helps to avoid the oxidation of the materials during the subsequent manufacturing phases reducing the risk of defective parts and improving the manufacturing yields.



Scanning tunneling microscope image from native oxide III-V surface vs. crystalline oxide III-V surface formed with Kontrox



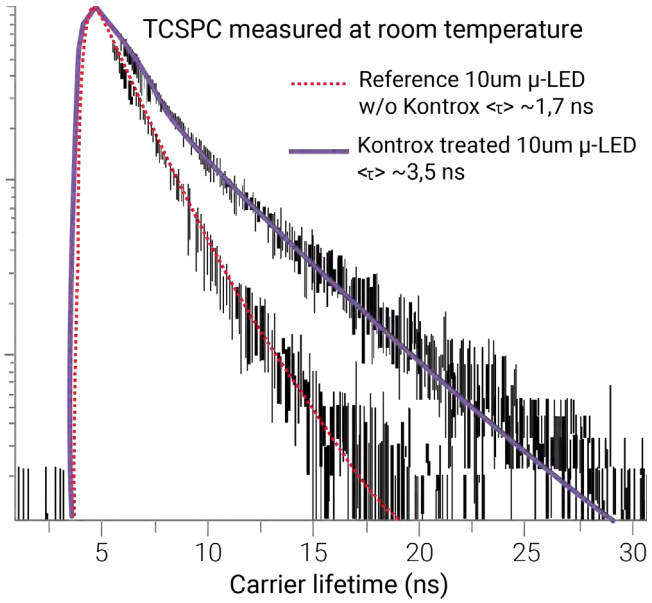
RHEED pattern from cleaned InGaAlP(100) surface showing (4x2) reconstruction and RHEED pattern after Kontrox treatment showing transformation of the surface reconstruction to (3x1) crystalline oxide

Up to 98% reduction of interface defect state densities

Peak EQE increase of up to 300%

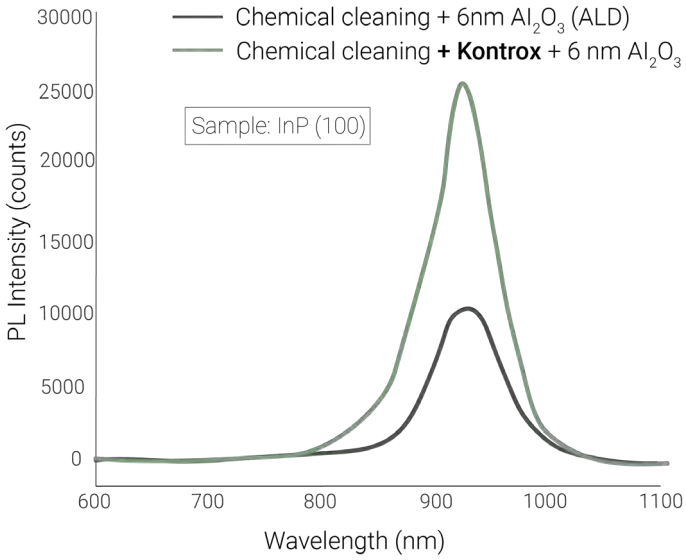
Stable against air exposure & high-temperature annealing

Substantial surface- and interface quality improvement



Minority carrier lifetime improvement with Kontrox

Optoelectronic device' surfaces passivated with Kontrox are characterized by unprecedented low levels of surface state densities and suppressed non-radiative recombinations. **This translates into a significant improvement in carrier lifetime and an increase in photoluminescence emission intensity.**



Photoluminescence comparison between state-of-the-art cleaning + ALD passivation and cleaning+Kontrox+ALD

Crystalline structures formed with Kontrox are stable against subsequent dielectric deposition and annealing and act as a **uniform, conformal passivation layer.** Applying Kontrox as an intermediate step before thin-film deposition (ALD/PECVD) further enhances the interface quality by allowing lower defect levels and, ultimately, less charge carrier trapping, resulting in **drastically improved quality of deposited layers.**

MESA sidewall passivation

- µLEDs
- IR detectors
- VCSELs

Improved performance

Lower manufacturing costs

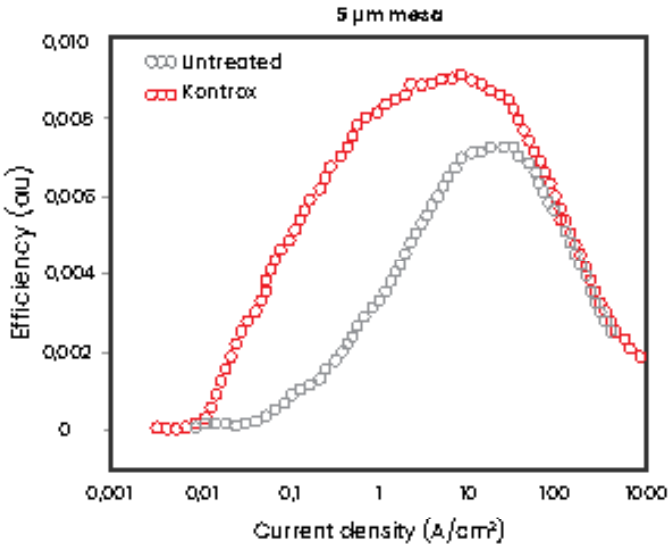
Key enabler for native µLED

Chip size reduction

MATERIALS SCOPE:

- GaN
- GaAs
- GaP
- InGaN
- AlGaN
- AlGaP
- AlGaAs
- InP
- AlGaInP
- InSb

Poor-quality oxide at the optoelectronic devices' mesa sidewalls and the related disorder-induced gap states are the biggest source of the SRH type of non-radiative recombination and leakage current and, consequently, diminished performance.



Efficiency improvement of a 5µm µLED with Kontrox

The oxidation of sidewall surfaces occurs as soon as the mesa is formed and the processed wafer is transferred to ambient air. Conventional methods do not deliver sufficient passivation quality and the density of sidewall defect states is still too high.

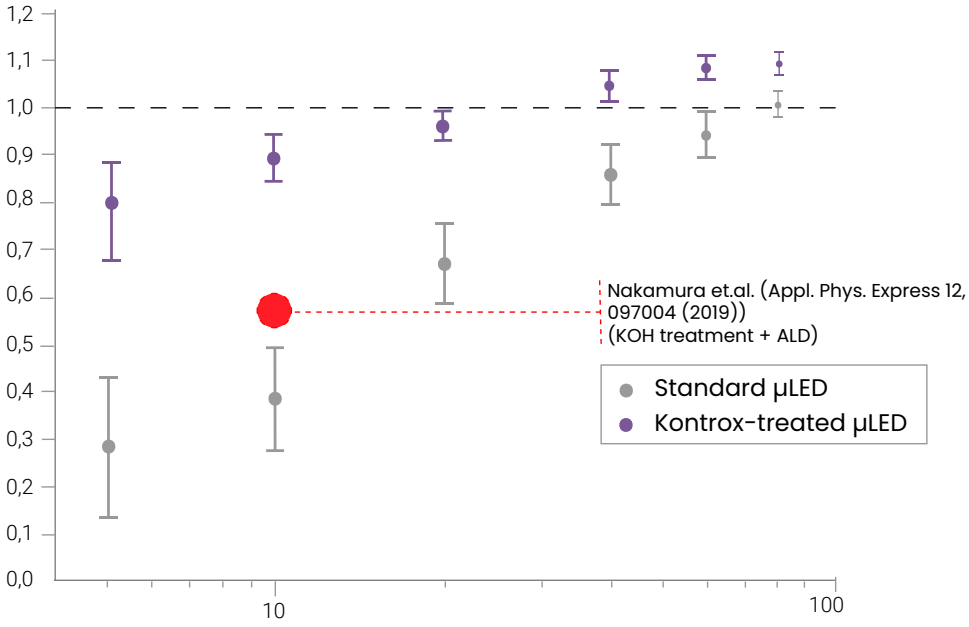
The reduction of non-radiative recombination achieved with Kontrox translates into significant efficiency improvement in e.g. small µLEDs. The peak EQE is drastically improved and shifted towards low current densities, indicating efficient elimination of sidewall recombinations.

Since a clean starting surface with a good quality crystal structure is the prerequisite for crystalline oxide formation, we apply our proprietary wet chemical and/or dry plasma processes before Kontrox passivation. This allows avoiding structural damage typically generated in e.g. ICP-RIE process.

Enabling next-generation µLED display

Despite their undeniable benefits, µLEDs are extremely difficult and expensive to produce, jeopardizing the technology's mass production. This is mostly due to high levels of oxidation-induced defects in III-V compounds commonly used in µLED devices.

Capable of generating high-quality III-V surface oxides, **Kontrox opens a totally new pathway towards realizing the highly efficient, mass-production grade µLED emitters for the next-generation displays.**

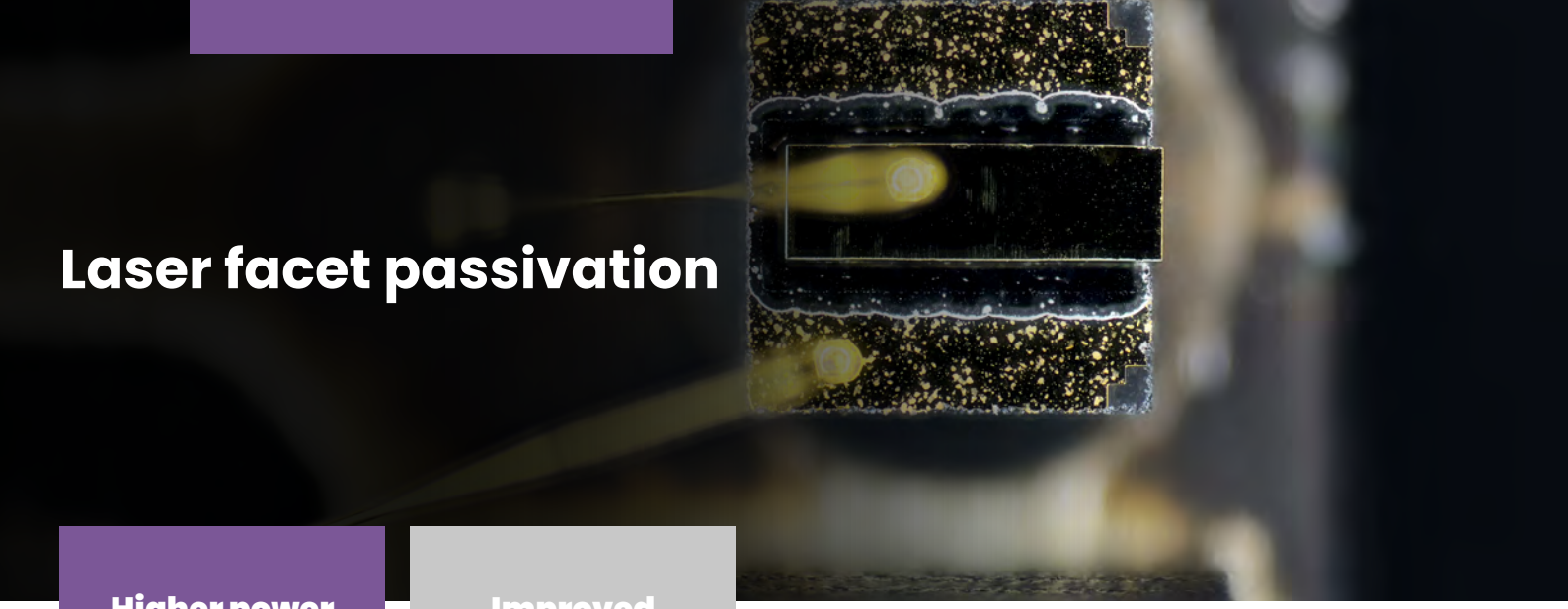


Size-dependent efficiency of a µLED relative to a state-of-the-art 80µm chip.

Get our white paper to learn more :

Kontrox enables a staggering reduction of the size-dependent efficiency of µLEDs: even the 5µm LED chip is as efficient as the 40µm one, allowing significant chip size reduction.
In addition, the performance distribution of the treated chips is much narrower, which has great implications in reducing the costly binning activities required in µLED display manufacturing.

Laser facet passivation



Higher power output

Improved reliability

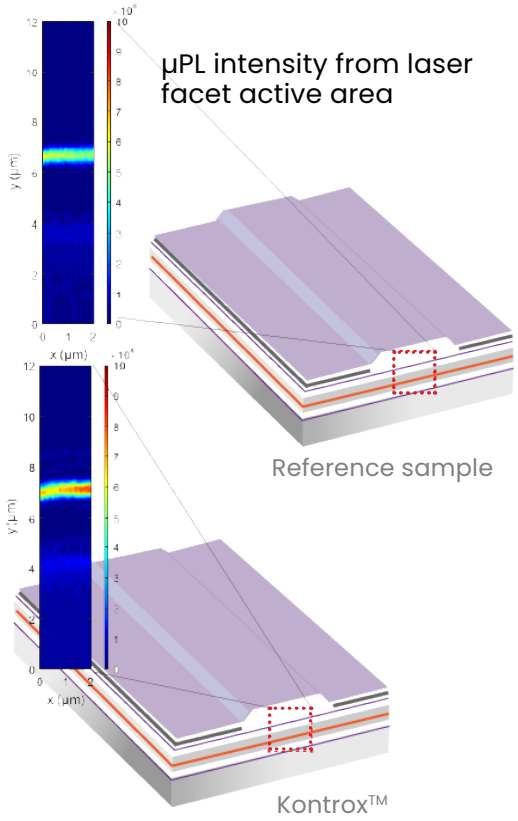
Increased COD threshold

Lower cost of ownership

MATERIALS SCOPE:

- GaAs
- AlGaAs
- InAlGaAs
- InGaAs
- InP
- GaInP
- AlGaInP

Effective passivation of laser facets is the key to obtaining the highest level of reliability and power output of edge-emitting lasers for key applications like optical communications, material processing, medical sensing, and optical storage. Techniques currently available in the market (e.g. ZnSe deposition, cleaving in UHV) are very costly, their outcome in terms of chip performance is somewhat limited depending on the materials contained in the chips, and manufacturing throughput is low.



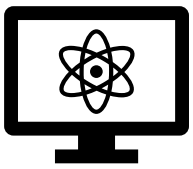
Comptek brings to the market a solution that improves laser reliability and power output levels with a **cost of ownership up to 40% lower than competitive methods.** With our novel solution, laser bars are cleaved in-air, after which treated with an optimized in-situ cleaning process.

Once a good clean facet is obtained, Kontrox is implemented in highly controlled conditions before applying the mirror coatings. This way, we achieve **results similar to the best processes currently available in the market at significantly reduced costs.**

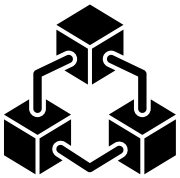
Technology transfer

We deliver **complete technology solutions** to meet the most demanding market specifications. We perform all necessary implementation- and optimization studies to seamlessly transfer and integrate customized passivation process into customers' manufacturing lines.

Process customization is carried out in Comptek´s laboratories and can be easily transferred to the customer R&D lines to speed up the process implementation. Through our partner network, we provide a **range of equipment solutions employing fully automated tools.** Our partners take care of equipment service and maintenance, while Comptek service team ensures impeccable process performance with **expert technical support and lifecycle management services.**



Freedom-to-operate under Comptek´s IP portfolio



Tailored process implementation to suit customer requirements

Customized equipment along with expert lifecycle management services

The information contained herein is intended to describe the state of Kontrox™ technology and may not reflect the product and/or process configurations at all times in the future. Kontrox™ is registered trademark of Comptek Solutions Oy.

More information on Comptek Solutions can be found at www.comptek-solutions.com.

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