Two-dimensional LIV, Spectrum and Beam Characterization of Individual Emitters in a VCSEL Array

Instrument Systems
KONICA MINOLTA Group

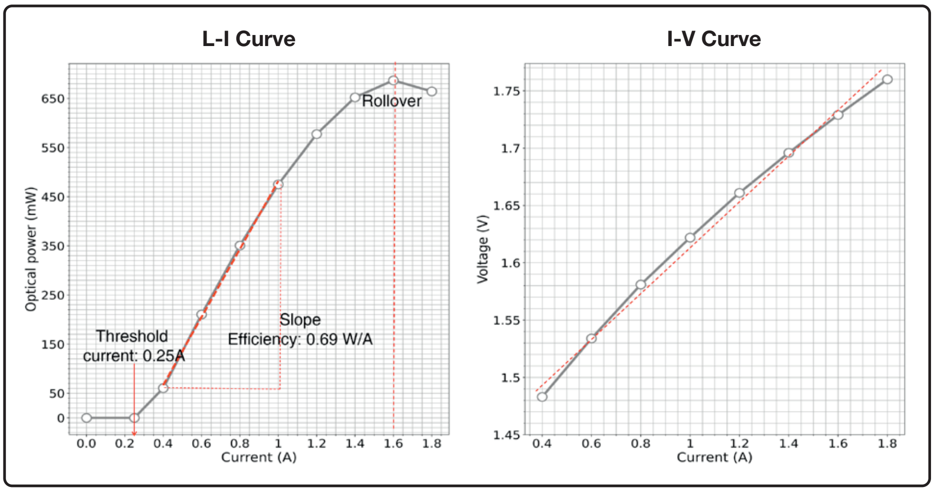
Necessity of 2D LIV+λ testing of individual emitters

- Crucial for demanding applications like facial recognition, 3D sensing, in-cabin sensing, LiDAR, and ranging.
- Investigating cross-talk between emitters.
- Parallelizing measurements and reducing the overall measurement time.

VCSEL arrays have found high-volume applications in consumer electronics, including Time-of-Flight (ToF) or structured light sources in 3D sensing, proximity illumination in Face Recognition (FR), Gesture Recognition (GR), and more. The focus of this study is on a detailed and comprehensive LIV test, spectrum and beam analysis of both the entire VCSEL array and each individual emitter within it. LIV curves are fundamental measurement of laser diodes to determine electrical and optical operating characteristics. These curves establish threshold current, slope efficiency, rollover point, the existence of any kinks, etc. They are widely used at various stages since it is critical to identify failed DUTs early in the manufacturing process.

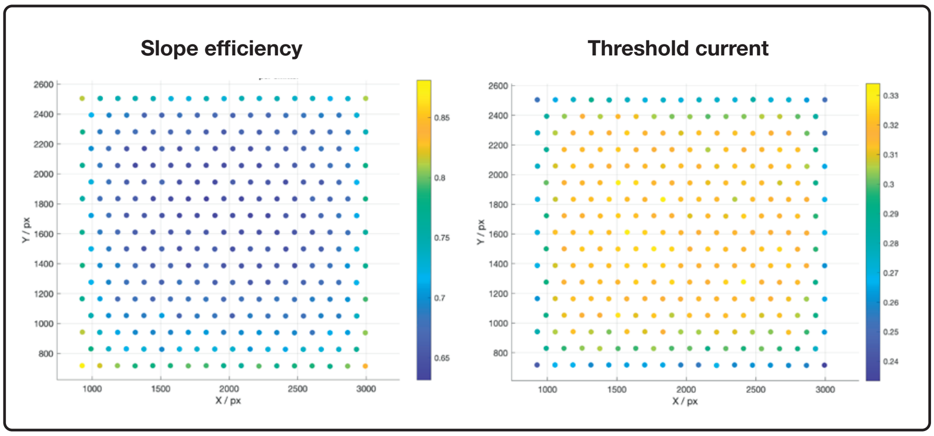
Please refer to the SPIE proceeding publication for more details: https://dx.doi.org/10.1117/12.2679760

LIV characterization of the whole VCSEL array



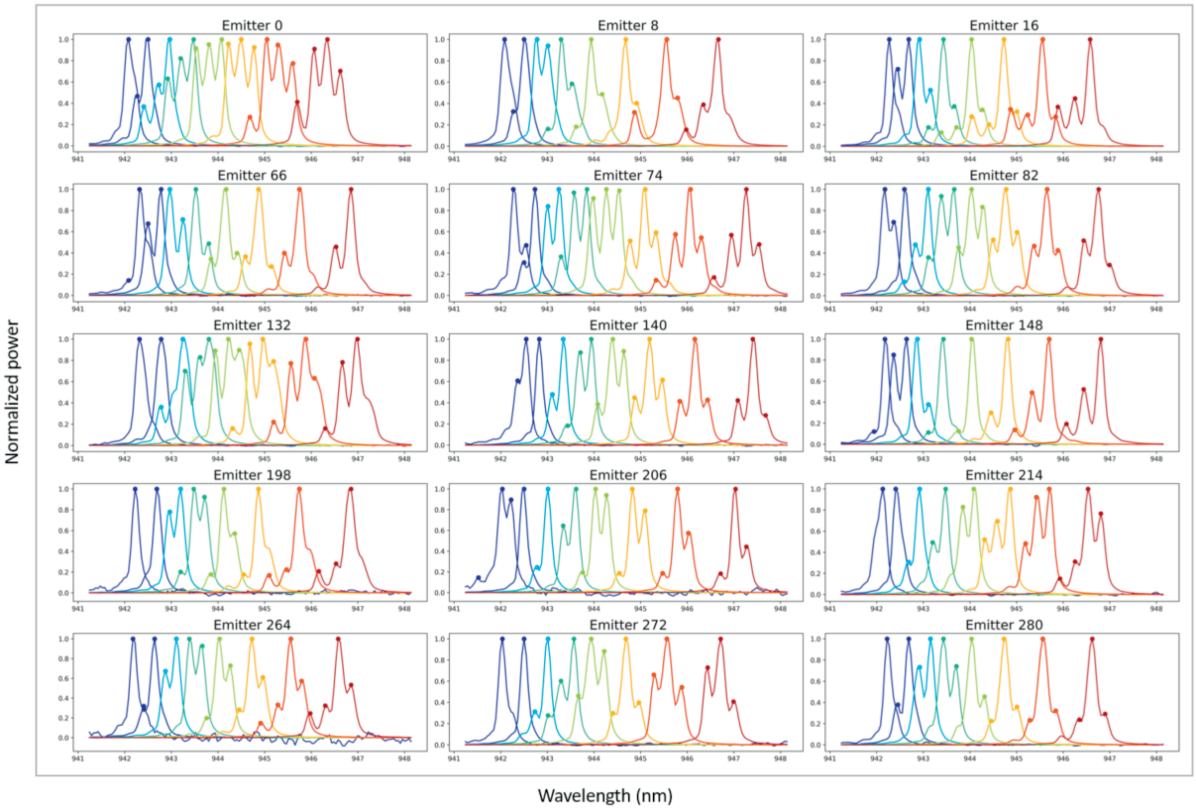
- L-I and I-V curve are measured for the whole array from 200 mA up to 1.8 A.
- The slope efficiency, threshold current and rollover current are calculated from the L-I curve.
- In the I-V curve, voltage increases roughly linearly with the current increase as expected.

LIV characterization of all emitters across the array



- The VCSEL array used in this measurement consists of 281 emitters.
- Slope efficiency and threshold current of each emitter are measured.
- The outer emitters have higher slope efficiency but lower threshold current.
- The inner emitters show minor variations in both quantities.

Besides LIV curves, we have measured the spectrum of individual emitters (15 emitters across the array were chosen) at different currents, similar to the LIV curves. The spectra are shown in the following figure. Each subplot represents an emitter, with its spectrum color-coded at different currents (blue at 400 mA up to red at 1.8 A). We observe a spectrum shift at higher currents, and high-order modes also appear with an increase in current.



CONCLUSIONS

Our unique measurement solution, with well-defined requirements from customers, allows for identifying underperforming or out-of-specification emitters within the array. We believe such comprehensive characterization of individual emitters is crucial for demanding applications. This enables the VCSEL maker to ensure final product compliance without incurring any packaging costs and speeds up the manufacturing process.

Scan for more information!

VTC 4000: ONE-SHOT SINGLE-EMITTER ANALYSIS

- Principle: 2D camera with microscope objective
- Wavelength range: 850 nm up to SWIR
- Calibrated at: 940 nm
- Optional: x/y scanning stage for extended field-of-view
- Optional: Fiber output port for spectral analysis
- Scope: Radiant power, M², beam waist, focus position, wavelength, FWHM, etc.
- **Highlight:** Polarization analysis
- **Highlight:** Traceable radiometric calibration