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

SPIE. DIGITAL OPTICAL TECHNOLOGIES

Instrument Systems
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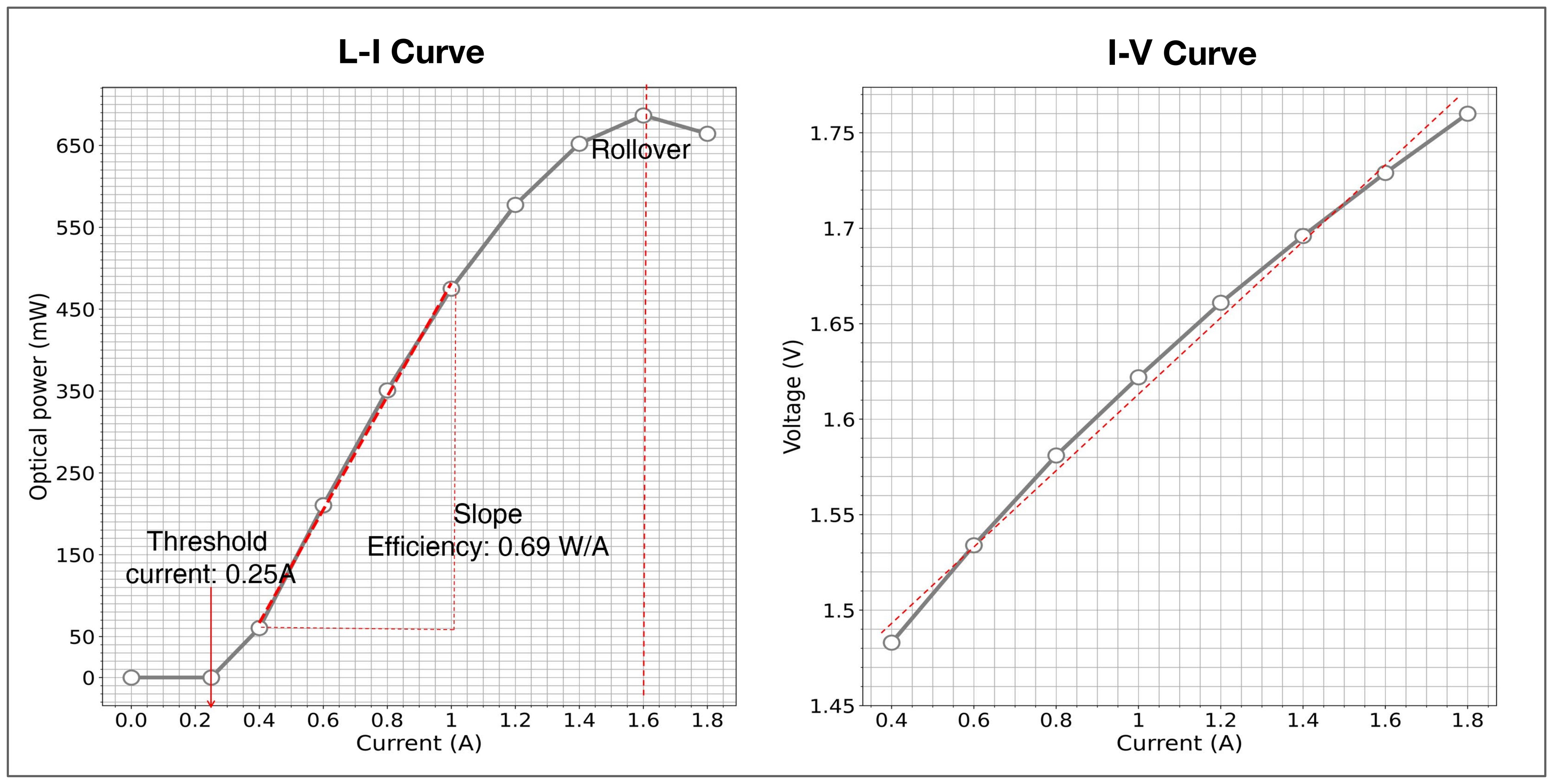
We extended existing one-dimensional LIV test, spectral and beam analysis to each single emitter of a VCSEL array. This approach allows parallelization of the measurements, which reduces overall measurement time, and offers investigation on the cross-talk between individual emitters. Such comprehensive characterization of individual emitters is crucial for demanding applications such as facial recognition, 3D sensing, in-cabin sensing, LiDAR and ranging.

INTRODUCTION

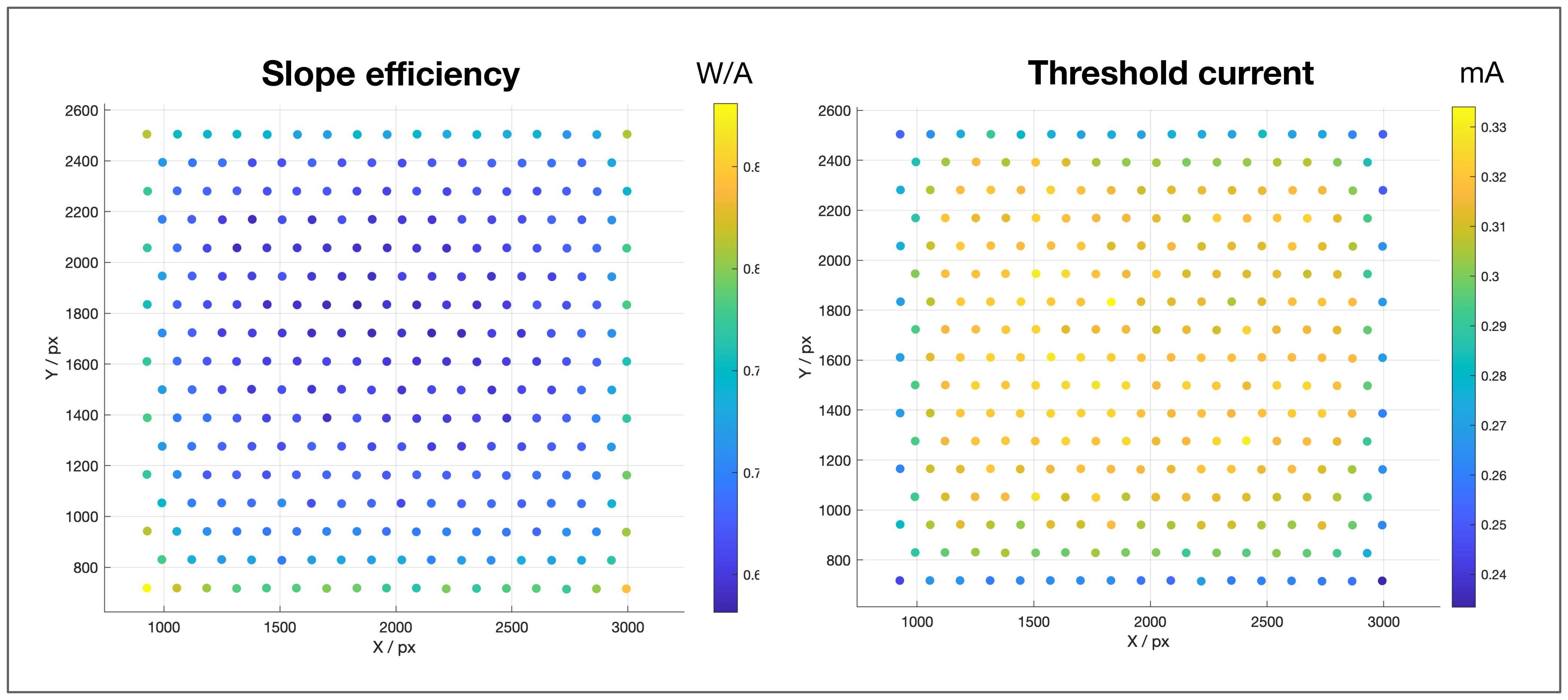
LIV curves are fundamental measurement of laser diodes to determine electrical and optical operating characteristics. These curves determine threshold current, slope efficiency, rollover point, existing of any kinks and more. They are widely used at various stages since it is critical to identify failed DUTs early in the manufacturing process. Detailed and comprehensive LIV test, spectrum and beam analysis of each single emitter of a DUT array is the focus of this study. VCSEL arrays found high volume applications in time of flight (ToF) or structured light sources in 3D sensing, proximity illumination in Face Recognition (FR), Gesture Recognition (GR), FMCW light sources in 3D ranging and LiDARs in automotive.

MEASUREMENT RESULTS

LIV characterization of the whole VCSEL array

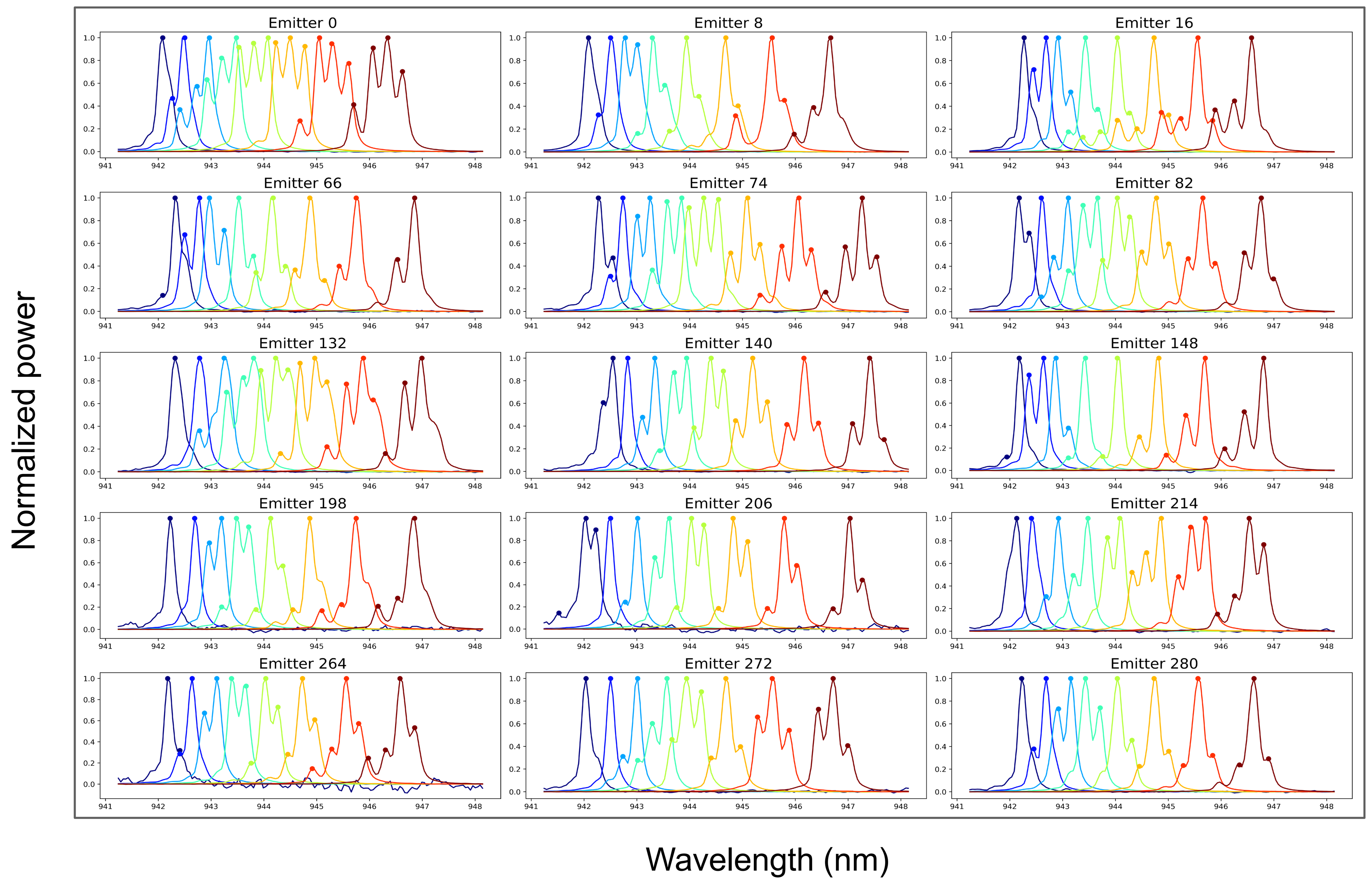


Slope efficiency and threshold current of emitters



The slope efficiency and the threshold current of each individual emitter of the array was measured. The outer emitters have higher slope efficiency but lower threshold current.

Spectrum analysis



We have chosen 15 emitters at different locations across the array to perform spectrum analysis. The spectrum of these emitters are measured at different currents. Each subplot is an emitter with its spectrum at different currents (blue at 400 mA up to red at 1.8 A). We observe that there is a spectrum shift at higher currents and as well high order modes appear by current increase.

CONCLUSIONS

In this study we tested a VCSEL array with 281 emitters. We performed LIV characterization of the whole array as well as the single emitters. Also, for each single emitter we measured the optical power, and spectrum of 15 chosen emitters across the array. All these measurements were done from 200 mA up to 1.8 A with the steps of 200 mA. The single shot capability of the near-field VTC 4000 allowed fast and reliable measurement of each single emitters in the array. Such comprehensive characterization of individual emitters is crucial for demanding application. Our solution with well defined requirements from customers allow identifying underperforming or out-of-specification emitters within the array. This enables the VCSEL maker to ensure the final product compliance without incurring any packaging cost and transforms manufacturing.

VTC 4000: ONE-SHOT SINGLE-EMITTER ANALYSIS

Key features at a glance

- **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