LOCC: Enabling the Characterization of On-orbit III-V Nitride-based LEDs
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Introduction

- West Virginia University and NASA IV&V team to launch a 3U CubeSat titled Simulation Testbed (STF-1).
- Launched scheduled June 2017 on board the Educational Launch of Nanosatellites (eLaNa) XIII.
- STF-1 includes testing of III-V Nitride-based LEDs due to unique radiation hardness.
- A Low-power Optoelectronic Characterizer for CubeSat (LOCC) has been designed to test in-house fabricated LEDs.
- A CubeSat mission provides an ideal platform for measuring LED and photodetector responsivity, IV characteristics, junction temperature, and electroluminescence in the space environment.

Device Fabrication and Characterization

- The LEDs used in the LOCC module are fabricated in the WVU Shared CleanRoom Facility.
- Comparison of the fabricated and house fabricated LEDs will allow for the effects of the space environment on the unpopulated III-V LED devices to be monitored via device characterization methods.
- The LOCC module in the CubeSat will serve to monitor the LEDs active region and its behavior in the space environment.
- Two methods of determining junction temperature will be applied: Forward voltage measurements and peak wavelength emission shifts.
- Fabrication of LEDs follows common semiconductor processing approaches, including nitrogen assisted annealing, photolithography, wet and dry etching, and metal deposition. The metal contacts were formed with alternating layers of titanium, aluminum, and gold.

Electroluminescent Characterizer

- Silicon based PIN diodes and analog-to-digital converter used to measure emission of LEDs.
- Using intrinsic values from an analog-to-digital converter (ADC), dominant wavelength can be calculated.
- Measurement devices allow for high sensitivity needed for small current measurements.
- Provides the needed experimental stability to obtain consistent, reliable results.
- Temperatures and radiation can have detrimental effects on the III-V based solid-state electronics, and will easily corrupt any results that may be obtained.

Current-Voltage Characterizer

- The design is based on the size constraints of the PC104 specification.
- Power and data limitations must be considered for adequate operation.
- Future design may scale power and available space based on the number of electronics devices and size of available.
- Low-power microcontroller to control the LOCC experiments which allows for programmable configuration of LED switching, voltage ramping, voltage sensing, and data management.

Power Budget

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<tr>
<th>Minimum</th>
<th>Maximum</th>
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<tbody>
<tr>
<td>Single</td>
<td>34</td>
</tr>
<tr>
<td>LED/PD (B)</td>
<td>1026</td>
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<tr>
<td>24 LED/PD (B)</td>
<td>888</td>
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</tbody>
</table>

Results

- Data budget for 24 LED/PD.

Summary

- Details regarding electrical characterization, and electroluminescence characterization have been illustrated.
- LOCC is in the prototyping stage with component procurement, new LEDs, I-V characterizer PCB fabrication, and the EL characterizer board design to be finalized in the coming months.
- For the exploration of space, novel electronic devices that are designed to function with a minimal amount of shielding and temperature swing mitigation must be able to withstand the extremes of the native space environment.

Acknowledgments

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