

PROCEEDINGS OF SPIE

# ***Gallium Nitride Materials and Devices V***

**Jen-Inn Chyi  
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*Editors*

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## Dedication



**Dr. Cole W. Litton**

It is with great honor and the deepest sadness that we dedicate these proceedings to the memory of **Cole W. Litton** who passed away while attending the conference on January 26, 2010, shortly after the completion of the last session that day. He cherished every aspect of organizing the conference and if he were to use a narrative for his passing it might not have been much different from what actually took place. The solace that we can all draw from this, if there is one, is that he passed on while doing what he loved most.

Dr. Litton started the series on Gallium Nitride Materials and Devices in 1996 and took care of all that had to be done on his own as his co-chair that year, Hadis Morkoç, was involuntarily committed to a myriad of other must do duties and could not be of much help. It is worth noting that the proceedings of the first Gallium Nitride Materials and Devices series was dedicated to commemorate the occasion of the retirement of his and our long time colleague Dr. G. L. Witt after many decades of service to the research community. Cole had dedicated himself to research and development as researcher and program manager, and also to his colleagues for many decades, in particular to his younger colleagues as they navigated through the complex web of science and engineering.

On the personal side, he was a kind and caring individual who never seemed to lose his composure under any circumstances. He will surely be missed by many whom he directly and indirectly touched, and will be affected by the absence of calming presence and guidance.



## Introduction

GaN based electronic and optoelectronic devices continue to develop rapidly as reflected by the advances reported at the meeting. Today, the GaN based light emitters adorn the automobiles, traffic lights, moving signs, outdoor displays, handheld electronics, and background lighting in many consumer electronics including flat panel televisions. All LED outdoor lighting applications are already in full swing. Indoor lighting with LEDs seems to be the frontier that GaN seems surely conquering with all manufacturers being under capacity due to increasing demand. The wall-plug efficiencies in excess of 50% at brightness levels needed for lighting certainly bode well for GaN based LEDs. Efficiency retention or the loss of it at high injection levels has received a great deal of attention due to the enormous impact of efficiency on indoor lighting by LEDs. To the end, non polar and semi-polar orientations of GaN and InGaN in the context of growth and investigations of optical processes are in full swing. Due to cost pressures, Si substrates for GaN epitaxy with clever patterning and strain balancing, to avoid cracking upon cooling from growth temperatures, being implemented. Measurement of internal quantum efficiency has been recognized to be an important step in the LED development for many years and the issue has come to the forefront in relation to GaN based LEDs as indicated by presentations and discussions on the topic.

The last year's program featured a good deal of shorter wavelength LEDs for medical applications, skin ailment treatment, curing of polymers, and applications such as water purification as well as short range communication are also being developed. The conference this year was representative of this push, but also a push for longer wavelengths for lasers as well as LEDs. The latter application is in part driven by lighting applications in case the tri-color approach, using red, green and blue LEDs, is used for general lighting applications.

Switching gears to FETs, the last year's program had a good deal of focus on both high power RF and switching applications of GaN based FETs and other three terminal devices. This year the focus centered on the carrier transport and the associated scattering mechanisms, the routes for heat dissipation from hot electrons to the heat sink. It was reported that the enhanced coupling of hot electrons with LO phonons and inability in general for LO phonons to LA phonons lead to high density of hot phonons with equivalent temperatures in the range of 2000 K, much like the hot electrons. With participation of plasmons, particularly at carrier densities corresponding to the plasma frequency that is resonant with GaN LO phonon energy efficient decay of LO phonons was noted and used to enhance carrier velocity and also improve reliability of FETs. Also introduced was

the use of low frequency noise measurement to measure the degree of degradation in FETs. These measurements were noted to be much more sensitive to degradation as compared to e.g. I-V measurements. Many devices, particularly FETs, are sensitive to surfaces and their preparation. Surface charge sensitive probes used to view not only the surface of GaN but also its evolution when subjected to various ambient conditions.

The SPIE symposium on GaN Materials and Devices is annually organized to disseminate the latest results and provide an opportunity for researchers from around the world to engage in far reaching and probing discussions. Many world renowned invited speakers from Asia, Europe and USA set the stage with wide ranging formal discussions. Not to be underestimated is the fact that the meeting served the purpose of getting experts and newcomers together for friendship and informal discussions of issues relevant to GaN and related materials and devices, and also to develop collaborations. Such exchanges will undoubtedly play an invaluable role in the propelling the field forward in general and in particular addressing pivotal issues such as determination and improvement of internal quantum efficiency in GaN and related materials and external quantum efficiency.

**Cole W. Litton** (*deceased*)  
**Jen-Inn Chyi**  
**Yasushi Nanishi**  
**Hadis Morkoç**  
**Joachim Piprek**  
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