Optoelectronics and Semiconductor Group

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Fields of study: III-V semiconductor lasers and light emitting diodes (LED), photodetectors, solar cells, crystal fiber light sources, and optical communications

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1. **Biography**

Dr. Pinghui Sophia Yeh received her Ph.D. in Electrical Engineering from University of Maryland, College Park, USA in 1995. Her dissertation was entitled: “High-power, high-gain, diffraction-limited emission from single-mode tapered semiconductor optical amplifiers.” Afterwards she worked for SDL, Inc., a world leader in making high-power laser diodes and EDFA (Er doped fiber amplifier) pump modules, located at San Jose, California. She was in charge of GaAs-based laser diode engineering and development including master oscillator power amplifier (MOPA) and high-speed high-temperature laser transmitter (SDL-5800), and was promoted as an Engineering Section Manager in 1999. After SDL was merged with JDS Uniphase in 2001, Dr. Yeh left the company and founded a high-tech startup, Optospace Technologies Inc., aimed at making novel optical components for optical communications and biophotonics. She received several SBIR (Small Business Innovation Research) awards: twice from NSF (National Science Foundation) in 2003 and 2005, and once from NIH (National Institutes of Health) in 2006. In 2007, Dr. Yeh took a faculty position at Department of Electronic and Computer Engineering and Graduate Institute of Electro-Optical Engineering, National Taiwan University of Science and Technology, located at Taipei, Taiwan and is now an Associate Professor. Her research interests include GaN-based LEDs, laser diodes, photodetectors, solar cells, and fiber-based light sources.

2. **Recent research topics**

(1) GaN-based LED and lasers

GaN-based LED and lasers have been extensively developed in recent years for applications in solid state lighting, display, data storage, optical communications, printing, etc. High power and high efficiency are two of the major goals for the industry. Based on my experiences on high-power GaAs-based laser diodes, we are developing new technology for making high-performance GaN-based devices. Figure 1 shows a GaN-based LED under probe testing. Figure 2 shows a photo of a GaN vertical-cavity surface emitting laser (VCSEL) which attained a sub-milliamp threshold current and a record-low divergence angle. A near single-mode continuous-wave VCSEL at room temperature was realized for the first time, to the best of our knowledge [5].

Fig. 1. Probe testing on a GaN blue LED.

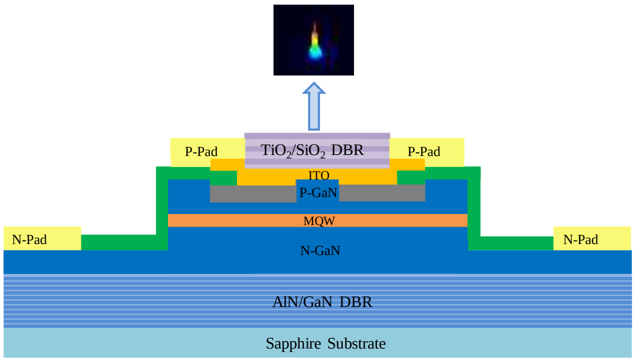

Fig. 2. Schematic structure of a GaN VCSEL [5]

(2) GaN-based photodetectors

GaN-based materials have wide band gaps that can detect shorter-wavelength light waves than silicon-based photodetectors. An AlGaInN-based heterojunction phototransistors was fabricated on an LED wafer for the first time. At a bias voltage of only 3 V, the corresponding photocurrent gain was approximately 790 [7]. Moreover, we demonstrated a monolithically integrated phototransistor and LED and its integrated operation [9].

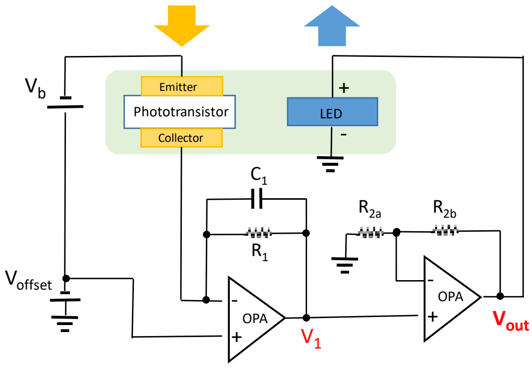

Fig. 3. Example circuit for a monolithically integrated phototransistor and LED [9].

Fig.4. Remote ultraviolet detection and warning

(3) Crystal fiber light sources

Some crystals have certain optical properties that traditional glass fibers or semiconductor laser materials cannot offer. When such crystal is grown into a crystal fiber compatible with standard fiber-optic components, new-function and all-fiber light sources can then be realized. Compared to traditional bulk crystal lasers, crystal fiber lasers not only require less pump power and less thermal management, but also provide a compact, portable, and robust package with fiber delivery that is basically maintenance-free and cost-effective.

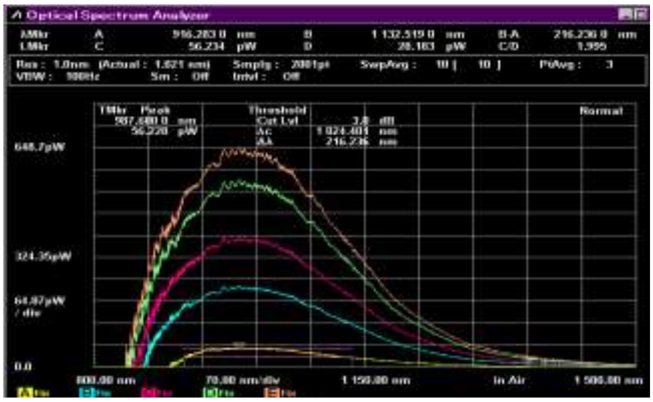

Fig. 5. Broadband emission spectrum of a Cr:forsterite crystal fiber

3. Selected publications

[1] P. S. Yeh, I-F. Wu, S. Jiang and M. Dagenais*, “High-power high-gain monolithically integrated pre-amplifier/power amplifier,” Electronics Letters, V. 29, n. 22, pp. 1981-1983, 1993.

[2] V. Dominic, S. MacCormack, R. Waarts, S. Sanders, S. Bicknese, R. Dohle, E. Wolak, P. S. Yeh, and E. Zucker, “110W fibre laser,” Electronics Letters, V. 35, pp. 1158-1160, 1999.

[3] C. Y. Lo, K. Y. Huang, J. C. Chen, C. Y. Chuang, C. C. Lai, S. L. Huang*, Y. S. Lin, and P. S. Yeh, “Double-clad Cr^{4+}: YAG crystal fiber amplifier,” Optics Letters, V. 30, n. 2, pp. 129-131, 2005.

[4] Pinghui S. Yeh*, Meng-Chun Yu, Jia-Huan Lin, Ching-Chin Huang, Yen-Chao Liao, Da-Wei Lin, Jia-Rong Fan, and Hao-Chung Kuo, "GaN-Based Resonant-Cavity LEDs Featuring a Si-Diffusion-Defined Current Blocking Layer," IEEE Photonics Technology Letters, V. 26, n. 24, pp. 2488-2491, 2014.

[5] P. S. Yeh*, C.-C. Chang, Y.-T. Chen, D.-W. Lin, J.-S. Liou, C. C. Wu, J. H. He, and H.-C. Kuo, "GaN-based vertical-cavity surface emitting lasers with sub-milliamp threshold and small divergence angle," Applied Physics Letters, V. 109, 241103, 2016.

[6] Yi-Ting Huang, Pinghui S. Yeh*, Yen-Hsiang Huang, Yu-Ting Chen, Chih-Wei Huang, Cong Jun Lin, and Wenchang Yeh, "High Performance InGaN p-i-n Photodetectors Using LED Structure and Surface Texturing," IEEE Photonics Technology Letters, V. 28, n. 6, pp. 605-608, 2016.

[7] Pinghui S. Yeh*, Teng-Po Hsu, Yen-Chieh Chiu, Sian Yang, Cheng-You Wu, and Jung-Shan Liou, "III-Nitride Phototransistors Fabricated on a Light-Emitting-Diode Epitaxial Wafer," IEEE Photonics Technology Letters, V. 29, n. 19, pp. 1679-1682, 2017.

[8] Yu-Chieh Chiu, Pinghui Sophia Yeh*, Tzu-Hsun Wang, Tzu-Chieh Chou,

Cheng-You Wu, and Jia-Jun Zhang, "An Ultraviolet Sensor and Indicator Module Based on p–i–n Photodiodes," Sensors, V. 19(22), 4938, 2019.

[9] Pinghui S. Yeh*, Yu-Chieh Chiu, Tsung-Che Wu, Yan-Xiang Chen, Tzu-Hsun Wang, and Tzu-Chieh Chou, "Monolithic integration of GaN-based phototransistors and light-emitting diodes," Optics Express, V. 27(21), 29854-29862, 2019.

[10] Yen-Yu Liu, Tsung-Che Wu, Pinghui S. Yeh*, "Etch-stop process for precisely controlling the vertical cavity length of GaN-based devices," Materials Science in Semiconductor Processing, V. 120, 105265, 2020.

4. Patents

(1) Ping-hui Yeh, Meng-Chun Yu, Jia-Huan Lin and Ching-Chin Huang, “Method to fabricate GaN-based vertical-cavity surface-emitting devices featuring silicon-diffusion defined current blocking layer”, U. S. patent number: 9819152, Issued date: Nov. 14, 2017, Expiration date: Oct. 7, 2035.

(2) 葉秉慧、余孟純、林家煥、黃景勤，“一種以矽擴散型電流阻擋層製作氮化鎵垂直共振腔面射型發光元件的方法”，中華民國專利發明第 I 563756 號，自 2016 年 12 月 21 日至 2034 年 12 月 23 日。

(3) 葉秉慧、李恆毅，“超寬頻近紅外線發光模組及產生超寬頻近紅外線的方法”，中華民國專利發明第 I 555290 號，自 2016 年 10 月 21 日至 2034 年 12 月 14 日。

(4) S. L. Huang, C. Y. Lo, K. Y. Huang, J. C. Chen, C. Y. Chuang, C. C. Lai, Y. S. Lin, and P. S. Yeh, “Transition metal doped fiber amplifier”, U. S. patent number 7333263, Issued date: February 19, 2008.

(5) 黃升龍、羅家堯、黃光堯、陳建誠、莊江源、賴建智、林彥勝、葉秉慧，“摻過渡金屬光纖放大器”，中華民國專利發明第 I 315806 號，自 2009 年 10 月 11 日至 2025 年 1 月 6 日。