

GaAs IC SYMPOSIUM

IEEE GALLIUM ARSENIDE INTEGRATED CIRCUIT SYMPOSIUM

Co-Sponsored by The IEEE Electron Devices Society,
The IEEE Microwave Theory and Techniques Society, and
The IEEE Solid-State Circuits Society

21st

Annual



TECHNICAL DIGEST 1999

MONTEREY, CA

OCTOBER 17-20, 1999

99CH36369

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WELCOME TO THE 1999 IEEE GaAs IC SYMPOSIUM

On behalf of the organizing committee and the IEEE EDS, MTT-S, and SSCS, I welcome you to the 21st (1999) IEEE GaAs IC Symposium in the beautiful city of Monterey, California at the DoubleTree and Marriott Hotels by Fisherman's Wharf on the Monterey Peninsula.

The GaAs IC Symposium continues its tradition of presenting the best from around the world in GHz frequency microelectronics. Forty percent of this year's technical papers come from outside the US. This year's program continues to demonstrate the strong growth in traditional commercial wireless applications, as well as an explosion of many new applications utilizing mm wave technologies. Major focus areas of this year's GaAs IC Symposium, organized by Jim Komiak and the Technical Program Committee, include state-of-the-art circuits and technology for:

- Wireless and broadband communications
- Very high-speed digital communications
- Highly-efficient, linear, power amplifiers
- Interface electronics and signal processing
- mm-wave defense and commercial systems

The technical sessions will highlight: GaAs IC manufacturing issues, new device development; device modeling, characterization, reliability; design techniques, and software.

This 21st IEEE GaAs IC Symposium continues our tradition of providing focused educational opportunities through our Short Course and Primer Course, both held on Sunday, October 17th. John Sitch has organized a very interesting and highly applicable one-day Short Course on "Millimeter Wave Systems" taught by five industry experts. In addition, Stephen Long and Donald Estreich will once again present our Primer Course on the "Basics of GaAs ICs" which is not only an excellent tutorial but is presented within the context of this year's symposium submissions.

To complement the full technical program, we have provided several social events to allow interactions with colleagues while catching up with the newest technology available on the market. These events include the Sunday evening Opening Reception, the Monday evening Technology Exhibition Reception in the GaAs IC Technology Exhibition Hall, and the Tuesday evening theme party at the world renowned Monterey Bay Aquarium.

We will provide the GaAs IC Technology Exhibition with approximately 40 exhibitors for you to learn of new products just hitting the market for our business. Additionally, potential customers for the latest commercially available GaAs ICs can learn about these in the Vendor Product Forum.

Finally, I want to announce the winner of our 2nd Outstanding Paper Award from the 1998 Symposium to T. Low et al. from Hewlett Packard for their paper "Migration from an AlGaAs to an InGaP Emitter HBT IC Process for Improved Reliability."

We are pleased you have chosen to join us in Monterey for the 21st IEEE GaAs IC Symposium. We know that we have an outstanding technical and educational program to support our business.

Mark Wilson
Chairman
1999 IEEE GaAs IC Symposium

1999 IEEE GaAs IC Symposium Organizers

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DoubleTree Hotel Monterey,
Monterey, California

Monterey Marriott Hotel,
Monterey, California

Monterey Conference Center,
Monterey, California

SYMPOSIUM AT A GLANCE

SATURDAY, OCTOBER 16, 1999

REGISTRATION (Short Course & Primer Course Only)

6:00 p.m.-8:00 p.m.

Portola Room-DoubleTree Hotel

SUNDAY, OCTOBER 17, 1999

REGISTRATION (Short Course & Primer Course Only)

7:00 a.m.-8:00 a.m.

De Anza Foyer-DoubleTree Hotel

Continental Breakfast for Short Course

7:00 a.m.-7:45 a.m.

San Carlos North Foyer-Marriott

SHORT COURSE: " Millimeter-wave Systems: Little Waves with a Big Impact."

8:00 a.m.-4:45 p.m.

San Carlos IV-Marriott Hotel

GaAs Reliability Workshop

8:00 a.m.-5:00 p.m.

De Anza III-DoubleTree Hotel

Short Course Lunch

12:20 p.m.-1:30 p.m.

Ferrantes Bayview-Marriott Hotel

REGISTRATION for Symposium (and Primer Course until 5:30)

5:00 p.m.-8:00 p.m.

De Anza Foyer-DoubleTree Hotel

PRIMER COURSE: "Basics of GaAs ICs"

5:30 p.m.-8:30 p.m.

San Carlos IV-Marriott Hotel

Symposium Opening Reception

5:00 p.m.-8:00 p.m.

De Anza Foyer-DoubleTree Hotel

MONDAY, OCTOBER 18, 1999

REGISTRATION

7:00 a.m.-5:00 p.m.

De Anza Foyer-DoubleTree Hotel

Continental Breakfast

7:00 a.m.-8:00 a.m.

De Anza Foyer-DoubleTree Hotel

SYMPOSIUM OPENING

8:00 a.m.-8:30 a.m.

De Anza I & II-DoubleTree Hotel

SESSION A: Plenary Session

8:30 a.m.-11:30 a.m.

De Anza I & II-DoubleTree Hotel

Break For Lunch

11:30 a.m.-12:30 p.m.

PANEL SESSION 1: InP Commercial Devices... When?

12:30 p.m.-2:00 p.m.

De Anza I-DoubleTreeHotel

PANEL SESSION 2: Is Ion Implantation Dead or Dying?

12:30 p.m.-2:00 p.m.

De Anza II-DoubleTree Hotel

SESSION B: Application Driven Device Technology

2:30 p.m.-4:20 p.m.

De Anza I-DoubleTree Hotel

SESSION C: HBTs and Novel Materials

2:30 p.m.-4:20 p.m.

De Anza II-DoubleTree Hotel

GaAs IC Technology Exhibition Opening Reception

5:00 p.m.-7:00 p.m.

Serra I Ballroom-Monterey Conf. Center (MCC)

SEMI Compound Semiconductor Standards Committee Meeting

8:00 p.m.-10:00 p.m.

TBA

TUESDAY, OCTOBER 19, 1999

REGISTRATION

7:00 a.m.-5:00 p.m.

De Anza Foyer-Double Tree Hotel

Continental Breakfast

7:30 a.m.-8:30 a.m.

Serra I Ballroom-MCC

GaAs IC TECHNOLOGY EXHIBITION

7:30 a.m.-4:00 p.m.

Serra I Ballroom-MCC

SESSION D: Advanced Power Amplifier Design

8:30 a.m.-10:00 a.m.

De Anza I-DoubleTree Hotel

SESSION E: Electro-Optic and Opto-Electronic Integrated Circuits

8:30 a.m.-10:00 a.m.

De Anza II-DoubleTree Hotel

SESSION F: Millimeter Wave Circuits and Front-End Devices

10:30 a.m.-12:00 p.m.

De Anza I-DoubleTree Hotel

SESSION G: FET Power Amplifiers

10:30 a.m.-12:00 p.m.

De Anza II-DoubleTree Hotel

Exhibition Luncheon

12:00 noon-1:30 p.m.

Serra I Ballroom-MCC

SESSION H: Millimeter Wave Power Amplifiers

1:30 p.m.-2:50 p.m.

De Anza I-DoubleTree Hotel

SESSION I: Device/Process Optimization & Hot Electron Effects

1:30 p.m.-2:50 p.m.

De Anza II-DoubleTree Hotel

PANEL SESSION 3: Let's Abandon Digital GaAs and Concentrate On What It's Good For

3:20 p.m.-4:50 p.m.

De Anza I-DoubleTree Hotel

VENDOR PRODUCT FORUM: New, Improved, Low Cost, WOW

3:20 p.m.-4:50 p.m.

De Anza II-DoubleTree Hotel

Symposium Party

7:00 p.m.-10:00 p.m.

Monterey Aquarium

WEDNESDAY, OCTOBER 20, 1999

REGISTRATION

7:00 a.m.-12:00 noon

De Anza Foyer-DoubleTree Hotel

Continental Breakfast

7:30 a.m.-8:30 a.m.

De Anza Foyer-DoubleTree Hotel

SESSION J: High Speed InP HBT Ics

8:30 a.m.-9:50 a.m.

De Anza I-DoubleTree Hotel

SESSION K: Frequency Converter and Transceiver MMICs

8:30 a.m.-9:50 a.m.

De Anza II-DoubleTree Hotel

SESSION L: Metamorphic HEMTs for Low Noise & High Power Millimeter Wave Applications

10:20 a.m.-11:30 a.m.

De Anza I-DoubleTree Hotel

Break For Lunch

11:30 a.m.-1:00 p.m.

De Anza I-DoubleTree Hotel

PANEL SESSION 4: Small Waves with BIG Problems: Packaging Issues. Who has the Solution ???!

1:00 p.m.-2:40 p.m.

De Anza I-DoubleTree Hotel

SESSION M: Millimeter Wave Sources, Dividers, & Multipliers

1:00 p.m.-2:40 p.m.

De Anza II-DoubleTree Hotel

SESSION N: Novel Control Circuits and Devices

3:10 p.m.-4:30 p.m.

De Anza I-DoubleTree Hotel

SESSION O: Mixed Signal and Digital Ics

3:10 p.m.-4:30 p.m.

De Anza II-DoubleTree Hotel

Close of Symposium

4:30 p.m.

Visit us on the World-Wide Web at:
<http://www.gaasic.org/>

Coffee Breaks:

Primer Course and Short Course Registrants (only) -

Sunday, October 17th: North Foyer-Marriott Hotel

Symposium Registrants -

Monday, October 18th:

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Zachary Lemnios, *MIT Lincoln Lab*

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PANEL SESSION 1

Monday, October 18, 1999 - 12:30 p.m. - 2:00 p.m.

InP COMMERCIAL DEVICES...WHEN?

Organizer & Moderator: Albert Baca, *Sandia National Laboratories*

We have been hearing or reading reports of these high performance and low noise InP devices for years now, but we wonder when if ever these devices will become commercially available. Our panel members represent companies that have plans to bring out commercial devices using InP HBT, InP HEMT, and metamorphic InP HEMT. They will give overviews of why their company's technology is commercially attractive. In addition, they will address some of the following questions:

Is there a market pull or technology push to get some of these devices out?

Do each of the InP technologies have their own niche or are they competing for the same turf?

Will the substrates be available in 4 inch and larger sizes?

Will they always cost a small fortune?

What are the pros and cons of metamorphic HEMTs on GaAs substrates?

Panel Members:

Dwight Streit	TRW
P.C. Chao	Lockheed Martin
Marko Sokolich	HRL
Kimiyoshi Yamasaki	NTT
John Blevins	AFRL

PANEL SESSION 2

Monday, October 18, 1999 - 12:30 p.m. - 2:00 p.m.

IS ION IMPLANTATION DEAD OR DYING?

Moderator: Robert Anholt, *Gateway Modeling*

With falling epi-wafer costs, are we at the point where the process simplicity afforded by using epi wafers offsets the added material costs? There are certain applications where epi is required (e.g. mm-wave HEMTs and high linearity transistors using Hi-lo-hi doping structures) and there are some where ion-implantation is, such as enhancement/depletion mode processes with more than one pinchoff voltage. This panel examines the fabrication of 2 GHz power amplifiers-technology where epi and ion-implantation are already competing. We consider the questions:

What are the cost tradeoffs?

How low in cost can epi go?

Are there quality, reliability, performance advantages even at 2 GHz where epi is worth the dough?

Panel Members:

Steve Mahon	Triquint
Stan Shanfield	Raytheon
C. Barratt	RFMD
T. Hierl	QED
Mark Wilson	Motorola

SESSION B

Monday, October 18, 1999 - 2:30 p.m.

Application Driven Device Technology

Chairpersons: Zachary Lemnios, *MIT Lincoln Lab*
Neng-Huang Sheng, *Rockwell Science Center*

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SESSION C

Monday, October 18, 1999 - 2:30 p.m.

HBTs and Novel Materials

Chairpersons: Tim Henderson, *TriQuint Semiconductor*
 Chris Bozada, *Air Force Research Laboratory*

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 Brad Nelson, *Space System/Loral*

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SESSION G

Tuesday, October 19, 1999 - 10:30 a.m.

FET Power Amplifiers

Chairpersons: Bill Peatman, *Motorola SPS*
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Kevin Kobayashi, *TRW*

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SESSION I

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Chairpersons: Brad Krongard, *M-A/COM*
Kenneth Russell, *The Aerospace Corporation*

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PANEL SESSION 3

Tuesday, October 19, 1999 - 3:20 p.m. – 4:50 p.m.

"LET'S ABANDON DIGITAL GaAs AND CONCENTRATE ON WHAT IT'S GOOD FOR"

Organizers/Moderators:

Bill Davenport, TriQuint Semiconductor

The digital context is for circuits operating at frequencies above 1.5 GHz. The panel will discuss the attributes of Si CMOS for digital and wireless and SiGe for digital and wireless, and GaAs for digital and wireless. How the strengths of each are manifested in the products and how well the strengths can be leveraged to capture or hold dominant positions in the digital and/or wireless markets. The Si and SiGe members can turn the statement to GaAs vs Si and SiGe by demonstrating how their market positions have evolved and how the strengths of each can be utilized to escalate market dominance for their digital and wireless products.

Panel Members:

Bob Bayruns	Anadigics -Support GaAs wireless
Tom Lee	Stanford -Support Si CMOS applications
MaryJo Nettles	AMCC -Support SiGe applications
Gary McCormack	Vitesse -Support GaAs digital

VENDOR PRODUCT FORUM – RFIC MMW MMICs, SIMULATION SOFTWARE, FOUNDRY SERVICES, AND MEASUREMENTS

Tuesday, October 19, 1999 - 3:20 p.m. – 4:50 p.m.

Chairman:

Mitch Shifrin,	Hittite Microwave Co.
George Oliver	ANADIGICS
Michael Poehl	INFINEON
Dominic Ogbonnah	TRIQUINT
George Studtmann	ITT-GTC
Dan Green	TRIQUINT

SESSION J

Wednesday, October 20, 1999 - 8:30 a.m.

High Speed InP HBT Ics

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Marko Sokolich, HRL Labs

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SESSION K

Wednesday, October 20, 1999 - 8:30 a.m.

Frequency Converter and Transceiver MMICs

Chairpersons:

Mohammad Madihian, NEC
Norman Chiang, California Eastern Laboratories

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SESSION L

Wednesday, October 20, 1999 - 10:20 a.m.

Metamorphic HEMTs for Low Noise & High Power Millimeter Wave Applications

Chairpersons:

Young-Kai Chen, *Lucent Technologies*
Jan-Erik Mueller, *Infineon-AG*

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PANEL SESSION 4

Wednesday, October 20, 1999 - 1:00 p.m. - 2:40 p.m.

SMALL WAVES WITH BIG PROBLEMS: PACKAGING ISSUES. WHO HAS THE SOLUTION???

Organizer/Moderator: Mitch Shifrin, *Hittite Microwave Corporation*
Norman Chiang, *California Eastern Laboratories*

High volume commercial millimeter wave systems have spurred the demand for low cost microwave and mmW packages. Package design must be user-friendly, testable, reliable, flexible, affordable, and perform in the desired bandwidth. Come join the fray along with a potpourri of expert vendors and users of packages. If you want to prove your worth and your pay, come to this panel and see the latest in a ball grid array packaging, bumped flip-chip, ceramic solutions, multi-chip module and cost targets. You will learn; WHO the players are, WHAT frequency ranges the technology is good for, WHERE testing bottlenecks can be avoided, WHEN lead times are critical which technology should be employed, and finally you will be able to say, "WHY limit yourself to these options I just attended a panel and learned of a better solution!". Be a reporter, question the experts, come to the panel and uncover the 5 Ws of high frequency packaging.

Panel members:

Bob Griffin	<i>MSC</i>
Terry Cisco	<i>Raytheon</i>
Dave Bates	<i>Dielectric Labs</i>
Keiichi Ohata	<i>NEC</i>
John Kennedy	<i>Alpha</i>

SESSION M

Wednesday, October 20, 1999 - 1:00 p.m.

Millimeter Wave Sources, Dividers, & Multipliers

Chairpersons: Mitchell Shifrin, *Hittite Microwave Co.*
Brad Nelson, *Space Systems/Loral*

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Mitchell Shifrin, *Hittite Microwave Co.*

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SESSION O

Wednesday, October 20, 1999 - 3:10 p.m.

Mixed Signal and Digital ICs

Chairpersons: John Sitch, *Nortel Networks*
Steve Long, *UCSB*

- O.1 WITHDRAWN MONOLITHIC 64QAM GaAs HBT MODULATOR**
R. Desrosiers, C. Hornbuckle, E. Mrozek, J. Lanphar, K. Kobayashi, A. Oki, B. Pointer, *TRW Electronics & Technology Division, Redondo Beach, CA*
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SESSION A

Monday, October 18, 1999 - 8:30 a.m.

PLENARY SESSION

Chairpersons: Robert Anholt, *Gateway Modeling*
Zachary Lemnios, *MIT Lincoln Lab*

- A.1 **GaAs...THE TECHNOLOGY OF THE FUTURE, FUTURE, FUTURE** (Invited Paper), A. Podell, *Besser Associates, Mountain View, CA*
- A.2 **THE 1999 OUTLOOK FOR GaAs IC MARKETS AND TECHNOLOGY** (Invited Paper), G. Bechtel, *Strategies Unlimited, Mountain View, CA*
- A.3 **WITHDRAWN III-V TECHNOLOGIES: AN INVESTORS' PERSPECTIVE ON THE MARKET** (Invited Paper), E. J. Lum, *Equity Research Analyst, Wireless Communications Equipment, CIBC World Markets, San Francisco, CA*
- A.4 **AlGaIn/GaN MICROWAVE POWER HEMT's** (Invited Paper), L.F. Eastman, *Cornell University, Ithaca, NY*
- A.5 **GaAs IC TECHNOLOGY IN ATE APPLICATIONS** (Invited Paper), A. Armstrong, *Vitesse Semiconductor, Camarillo, CA*

