

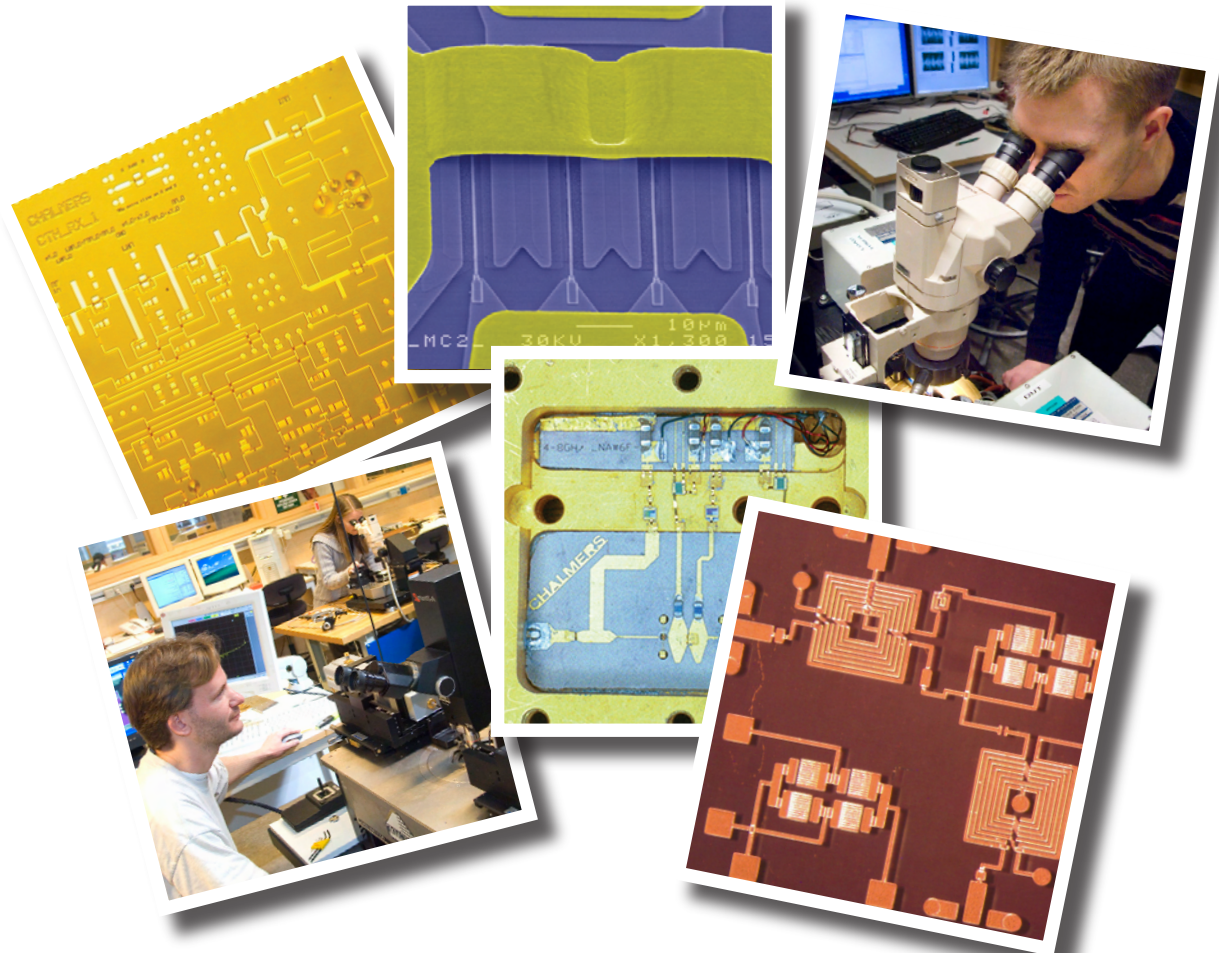
CHALMERS

ABSTRACT BOOK

GIGAHERTZ SYMPOSIUM 2008

5-6 MARCH 2008

CHALMERS UNIVERSITY OF TECHNOLOGY
GÖTEBORG
SWEDEN



GHR CENTRE

MC2
Microtechnology and Nanoscience

microwave
road

VINNOVA

IEEE

SNRV
Svenska Nationalkommittén
för RadioVetenskap

GigaHertz Symposium 2008

**5-6 March 2008
Chalmers University of Technology
Göteborg
Sweden**

www.ghz2008.se

**Chalmers University of Technology
Department of Microtechnology and Nanoscience - MC2
GigaHertz Centre
Microwave Electronics Laboratory
SE 412 96 Göteborg, Sweden**

Editor: Jan Grahn, Chalmers University of Technology

**Technical Report MC2-125
ISSN 1652-0769**

This Abstract Book is reported in Chalmers Publication Library:

<http://publications.lib.chalmers.se/cpl/>

This Abstract Bok is possible to download in pdf format at www.chalmers.se/ghz



www.chalmers.se/ghz


Microtechnology and Nanoscience

www.chalmers.se/mc2


microwaveroad

www.microwaveroad.se



www.ieee.com


Svenska Nationalkommittén
för RadioVetenskap

www.radiovetenskap.kva.se

Exhibitors & Sponsors GHz Symposium 2008

Platinum sponsor:

**Swedish Governmental Agency
for Innovation Systems
(VINNOVA)**

www.vinnova.se



Gold sponsor:

Agilent technologies

www.agilent.com



Agilent Technologies

Silver sponsors:

Ageto MTT

www.agetomtt.se



AMSKA

www.amska.se



Amtele

www.amtele.se



Anritsu

www.anritsu.se



Applied Wave Research

<http://web.appwave.com>



MicroComp Nordic AB

www.mcnab.se



National Instruments

www.ni.com



Ranatec Instruments

www.ranatec.se



Rohde Schwarz

www.rohde-schwarz.se



Wasa Millimeter Wave

www.wmmw.se



GigaHertz Symposium 5-6 March 2008 at Chalmers

www.ghz2008.se

Chalmers Conference Center, Chalmers University of Technology

Wednesday 5 March 2008

0830-1000 Registration Coffee + Sandwich

SILVER SPONSORS: Wasa Millimeter Wave AB Applied Wave Research Inc.

1000-1200 SESSION I Runan Chairman: Jan Grahn, Chalmers

1000 Welcome

Jan Grahn, Chalmers; General Chairman GHZ Symposium 2008

Stefan Bengtsson, Vice President, Chalmers

1010 Plenary invited speaker

Intelligent Transmitter Technology for Next Generation Wireless Transceivers

Larry Larson

Univ. California San Diego

1050 Invited speaker

RF/DSP co-designed power amplifiers/transmitters for advanced wireless and satellite applications

Fadhel Ghannouchi

Univ. Calgary

1120

Tuneable technologies for agile microwave systems

S. Gevorgian

Chalmers, Ericsson

Design and Verification of a GaN S-band high power amplifier

J. Nilsson

Saab Microwave Systems

Self-Oscillating RF amplifiers

P. Reynaert, W. Laflere, M. Steyaert, J. Craninckx

KU Leuven, IMEC, Leuven

1200-1300 Lunch and Exhibition

GOLD SPONSOR: Agilent

1300-1500 Workshops Wednesday 5 March 2008

Agile Microwave Systems	RF Power Amplifiers (1)	Microwave Components	THz Technology
Ascom/Catella Moderator: Hans-Olof Vickes Saab Microwave Systems	Runan Moderator: Bo G. Berglund Ericsson	Scania Moderator: Sven Mattisson Ericsson Mobile Platforms	Valdemar/Ledning Moderator: Staffan Rudner Swedish Defence Research Agency - FOI
A method for switchable rejection filters N. Meissner Saab Avionics	The Frequency Spectrum of Bandpass Pulse Width Modulated Signals T. Blocher, P. Singerl, A. Wiesbauer, F. Dielacher Graz Univ., Infineon	Highly Integrated MMICs for mm-wave system application H. Zirath, S.E. Gunnarsson, M. Ferndahl, R. Kozhuharov, C. Kärfelt Chalmers, Ericsson	Invited WS speaker: An introduction to the T4000 terahertz imager C. Mann Thruvision Ltd., Abingdon, UK
60 GHz $\lambda/8$ Phase-Shifter in EFFA Technology X. Rottenberg, P. Ekkels, B. Nauwelaers, W. De Raedt Imec, KU Leuven	The potential of active load and source tuning on base station power amplifiers T. Lejon Ericsson	An Ultra Wide Band LNA in 90 nm CMOS W. Ahmad, A. Axholt, H. Sjöland Lund Univ	
Tuneable Filters for Agile Microwave Systems A. Deleniv, S. Gevorgian Chalmers, Ericsson	Comparing Polar Transmitter Architectures using GaN HEMT Power Amplifier E. Cijvat, K. Tom, M. Faulkner, H. Sjöland Lund Univ., Victoria Univ., Melbourne	Flip Chip for High Frequency K. Boustedt Ericsson.	Novel 220 GHz Slot-Square Substrate Lens Feed Antenna Integrated on MMIC J. Svedin, S. Leijon, N. Wadefalk, S. Cherednichenko, B. Hansson, S. Gunnarsson, I. Kalfass, A. Leuther, A. Emrich FOI, Chalmers, Fraunhofer-IAF, Omnisys Instruments

Agile Microwave Systems (cont')	RF Power Amplifiers (1) (cont')	Microwave Components (cont')	THz Technology (cont')
<p>Microwave MEMS activities at the Royal Institute of Technology J. Oberhammer, N. Somjit, <u>M. Sterner</u>, F. Saharil, S. Braun, G. Stemme KTH</p>	<p>Invited WS speaker:</p> <p>Class MTM Power Amplifier Linearization D. E. Kelly PulseWave RF, Austin</p>	<p>Cryogenic X-band Low Noise Amplifiers N. Goia, M. Kelly, A. Malmros, N. Wadefalk, <u>J. P. Starski</u> Chalmers</p>	<p>Planar antennas for terahertz frequencies S. Cherednichenko Chalmers</p>
<p>Phase-Comparison Monopulse Direction Measurement Antenna Array for 6-18 GHz C. Johansson, T. Eriksson, J. Grabs, T. Windahl Saab Avionics</p>	<p>Different Classes of Power Amplifiers using SiC MESFET S. Azam, R. Jonsson, Q. Wahab Linköping Univ., FOI</p>	<p>Low-Noise Cryogenic Amplifier built using MMIC-like /TRL Technique O. Nyström, <u>E. Sundin</u>, D. Dochev, V. Desmaris, V. Vassilev, V. Belitsky Chalmers, Onsala Space Observatory</p>	<p>Geosynchronous Earth Orbit Atmospheric Sounder S. Andersson, <u>J. Embretsen</u>, A. Emrich, M. Ericson, M. Hjort, J. Riesbeck, C. Tegnander Omnisys Instruments</p>
<p>MEMS Phase Shifters for an Affordable Low-Power Ka-band Multifunctional ESA on a small UAV R. Malmqvist, C. Samuelsson, A. Gustafsson, <u>T. Boman</u>, S. Björklund, B. Carlegrim, R. Erickson, T. Vähä-Heikkilä, P. Rantakari FOI, Millilab-VTT</p>	<p>Modeling of dual-input power amplifiers T. Eriksson, C. Fager, H. Cao, A. Soltani, U. Gustavsson, H. Nemati, H. Zirath Chalmers</p>	<p>Small-Signal Modeling of Narrow bandgap InAs/AlSb HEMTs M. Malmkvist, E. Lefebvre, L. Desplanque, X. Wallart, G. Dambrine, S. Bollaert, J. Grahn Chalmers, IEMN Lille</p>	<p>Back-End Module Demonstrator for radio-astronomy applications J.L. Cano, B. Aja, E. Villa, L. de la Fuente, E. Artal Univ. Cantabria, Santander</p>
<p>An adjustable broadband MMIC equalizer J. Grabs, U. Öhman, N. Meissner Saab Avionics</p>	<p>Invited WS speaker:</p> <p>Recent Advances in GaN HEMT Power Amplifier Technology for Telecommunication Applications</p>	<p>Low-Noise, High-Speed Strained Channel Silicon MOSFET Technology for RF-Applications B.G. Malm, J. Hällstedt, P.-E. Hellström, M. Östling Royal Institute of Technology</p>	<p>ALMA Band 5 (163-211 GHz) Sideband Separating Mixer B. Billade, I. Lapkin, A. Pavolotsky, R. Monje, J. Kooi, V. Belitsky Chalmers, California Institute of Technology</p>
<p>Tunable Impedance Matching Network M. R. Rafique, T. A. Ohki, P. Linnér, A. Herr Chalmers</p>	<p><u>R. Pengelly</u>, S. Wood, D. Farrell, B. Pribble, J. Crescenzi Cree Inc., Central Coast Microwave Design, US</p>	<p>Wideband Microstrip 90° 3-dB Two-Branch Coupler with Minimum Amplitude and Phase Imbalance D. Wang, M. Li, A. Huynh, <u>P. Håkansson</u>, S. Gong Nanjing Electronic Equipment Institute, Linköping University</p>	<p>High Power Photonic MW/THz Generation Using UTC-PD B. Banik, J. Vukusic, H. Hjelmgren, H. Sunnerud, A. Wiberg, J. Stake Chalmers</p>
<p>Coded OFDM in Hybrid Radio Over Fibre Links J.F. Miranda, M. Gidlund Univ. Gävle, Nera Networks</p>		<p>An Ultra-Wideband Six-Port transceiver Covering from 3.1 to 4.8 GHz <u>P. Håkansson</u>, S. Gong Linköping Univ</p>	<p>Towards a THz Sideband Separating Subharmonic Schottky Mixer P. Sobis, J. Stake, A. Emrich Chalmers, Omnisys Instruments</p>
<p>Equivalent Circuit of Metamaterials with a Negative Permeability A. Rumberg, M. Berroth Univ. Stuttgart</p>	<p>Design Consideration for Varactor-Based Dynamic Load Modulation Networks U. Gustavsson, B. Almgren, H. Nemati Ericsson, Chalmers</p>	<p>Gated tunnel diode pulse generator M. Nilsson, M. Årelid, E. Lind, G. Astromskas, L.-E. Wernersson Lund Univ.</p>	<p>HIFAS: High-Performance full-custom Autocorrelation Spectrometer ASIC A. Emrich, S. Andersson, <u>M. Hjort</u> Omnisys Instruments</p>

1500-1530 Coffee and Exhibition SILVER SPONSORS: Anritsu Ageto MTT
1530-1730 SESSION II Runan Chairman: Piotr Starski, Chalmers
1530 Invited speaker Extremely Low-Noise Amplification with Cryogenic FET's and HFET's: 1970-2006 (Where do we go from here?) Marian W. Pospieszalski National Radio Astronomy Observatory, Charlottesville, VA
1600 560 GHz f_t , f_{max} operation of a refractory emitter metal InP DHBT E. Lind, A.M. Crook, Z. Griffith, M.J. Rodwell Lund Univ., Univ. California Santa Barbara
Low phase-noise balanced Colpitt InGaP-GaAs HBT VCOs with wide frequency tuning range and small VCO-gain variation H. Zirath GHz Centre, Chalmers, Ericsson
Feasibility of Filter-Less RF Receiver Front-End S. Ahmad, N. Ahsan, A. Blad, R. Ramzan, T. Sundström, H. Johansson, J. Dabrowski, C. Svensson Linköping University
Small-Size 2-10 GHz Radar Receiver Si-RFIC H. Berg, H. Thieses, M. Hertz, F. Norling Saab Microwave Systems
High frequency, current tunable spin torque oscillators: experimental characterization S. Bonetti, J. Garcia, J. Persson, J. Åkerman Royal Institute of Technology
N -coupling the capacity of wireless communication using electromagnetic angular momentum B. Thidé Swedish Institute of Space Physics, Uppsala
1730-1830 Visit (optional) MC2 Cleanroom or Microwave Labs, Chalmers (www.chalmers.se/mc2)
1900 Conference Dinner at Universeum (www.universeum.se)

Thursday 6 March 2008
0830- 1000 SESSION III Runan Chairman: Herbert Zirath, Chalmers
0830 Plenary invited speaker The Next Wireless Wave is a Millimeter Wave Joy Laskar GeorgiaTech
0910 Invited speaker High Frequency and Mixed Signal Design for Communication and Remote Sensing applications in advanced technologies Mehran Mokhtari Teledyne Scientific
0940 MMIC design at G-band (140-220 GHz) including a 220 GHz Single-Chip Receiver MMIC with Integrated Antenna S.E. Gunnarsson, N. Wadefalk, M. Abbasi, C. Kärnfelt, R. Kozhuharov, J. Svedin, B.M. Motlagh, B. Hansson, S. Cherednichenko, I. Angelov, D. Kuylenstierna, H. Zirath, S. Rudner, I. Kalfass, A. Leuther Chalmers, FOI, Ericsson, Fraunhofer-IAF
A Quad-Core 130-nm CMOS 57-64 GHz VCO V. P. Goluguri, J. Wernehag, H. Sjöland, N. Troedsson Cambridge Silicon Radio Sweden, Lund University
1000-1030 Coffee and Exhibition SILVER SPONSORS: Amtele AMSKA MicroComp Nordic

1030-1210 SESSION IV Runan Chairman: Niklas Rorsman, Chalmers			
1030 Invited speaker GaN HEMT development for microwave power applications- Current status and trends Masaaki Kuzuhara Univ. Fukui			
1100 Paving the road for integrated gallium nitride transceivers K. Andersson, M. Thorsell, N. Billström, J. Nilsson, J. Holmkvist, A-M. Andersson, M. Südow, M. Fagerlind, P.-Å. Nilsson, A. Malmros, H. Hjelmgren, N. Rorsman, GHz Centre, Chalmers, Saab			
Demonstrator of Class-S Power Amplifier A. Samulak, G. Fischer, R. Weigel Univ. Erlangen-Nürnberg, Alcatel-Lucent			
30/20 GHz Balanced Sub-harmonic MMIC Mixer for Space Applications D. Kleén, J. Thelberg Saab Space			
Water Vapour Radiometer for ALMA A. Emrich, M. Wannerbratt Omnisys Instruments			
European Radio & Microwave Interest Group (EuRaMIG) - An initiative from GHz Centre: Status and Coming Activities P. Olanders, Ericsson, Chairman GHz Centre, J. Grahn, Chalmers, Director GHz Centre			
1210-1300 Lunch and Exhibition PLATINUM SPONSOR: VINNOVA			
1300-1430 Workshops		Thursday 6 March 2008	
Antennas Ascom/Catella Moderator: Per Sjöstrand Saab Avionics	RF Power Amplifiers (2) Runan Moderator: Johan Ståhl Saab Microwave Systems	Measurement - Modeling Scania Moderator: Niclas Keskitalo Ericsson	The GHz Entrepreneur Valdemar/Ledning Moderator: Peter Wahlberg Microwave Road
Integrated Antennas for RF MEMS Routes A. Rydberg, S. Cheng, P. Hallbjörner, S. Ogden, K. Hjort Uppsala Univ., SP, Borås Presented by C. Karlsson, SP	Output Power Density and Breakdown Voltage in Field-Plated Buried Gate Microwave SiC MESFETs P.Å. Nilsson, F. Allerstam, K. Andersson, M. Fagerlind, H. Hjelmgren, A. Malmros, M. Südow, E.Ö. Sveinbjörnsson, H. Zirath, N. Rorsman, Chalmers	Model-Based Pre-distortion for Signal Generators C. Luque, N. Björnell Univ. Gävle	<i>The WS provides some personal reflections on doing business from innovations and IP in RF/Microwave from three small companies, one global company and one venture company. The WS is concluded by a discussion</i>
Microstrip patch antenna for wireless applications N.A. Touhami, B. Aja, A. Tazón, E. Artal Univ. Cantabria, Santander	Silicon-on-SiC hybrid substrate with low RF-losses and improved thermal performance J. Olsson, Ö. Vallin, D. Martin, L. Vestling, U. Smith, H. Norström Uppsala Univ., Infineon	A Comparison of Antenna Diversity Characterization Methods using Reverberation Chambers and Drive Tests D. Nyberg, M. Franzén, P.S. Kildal Chalmers, Bluetest AB	Mikael Reimers, CEO Foodradar Systems AB www.foodradar.com
Small Microstrip Fractal Antenna for RFID Tag P. Enoksson, M. Rusu, A. Curutiu, H. Rahimi, C. Rusu Chalmers, Bucharest Univ., Bonn Univ., Imego	A review of validation criteria for behavioral power amplifier models P. Landin, M. Isaksson, Univ. Gävle	Measuring Relative Receiver Sensitivity of Wireless Terminals in One Minute in a Reverberation Chamber M. Andersson, C. Orlenius, M. Franzén Bluetest AB	Tomas Ornstein, CEO Ranatec Instrument AB www.ranatec.se

Antennas (cont')	RF Power Amplifiers (2) (cont')	Measurement - Modeling (cont')	The GHz Entrepreneur (cont')
Dual-band choke horn Eleven Feed A. Yasin, J. Yang, T. Östling Chalmers, Arkivator AB	CMOS for micro- and millimeter-wave power applications M. Ferndahl, H. Nemati, H. Zirath Chalmers Comparative analysis of the complexity/accuracy tradeoff for power amplifier behavior models A. Tehrani, H. Cao, T. Eriksson, C. Fager, Chalmers	Modeling of SiGe HBT Operation in Extreme Temperature Environment P. Sakalas, M. Ramonas, M. Schroter, A. Kittlaus, H. Geisler, C. Jungemann, A. Shimukovitch Dresden Univ.; Semiconductor Physics Institute, Vilnius; SUSS Microtec, Bundeswehr Univ. Neubiberg; Univ. California San Diego	Johan Lassing, CEO Qamcom Technology AB www.qamcom.se
Optimization of 200-800 MHz Eleven Feed for Use in Reflector Antennas of GMRT Y.B. Karandikar, P.S. Kildal Chalmers	A Computational Load-Pull Investigation of Harmonic Loading Effects on AM-PM conversion O. Bengtsson, L. Vestling, J. Olsson Univ. Gävle, Uppsala Univ.	On-wafer network analyser uncertainty estimation J. Stenarson, K. Andersson, C. Fager, K. Yhland SP Borås, Chalmers	Peter Olanders, Technology Strategist Ericsson AB www.ericsson.com
Method for Circuit Based Optimization of Radiation Characteristics of Multi-port Antennas K. Karlsson, J. Carlsson SP Borås, Chalmers	Identification of Distortions in a RF Measurement System H. Cao, A. Soltani, C. Fager, T. Eriksson Chalmers	Mm-wave device testing using wideband coplanar transitions E. Villa, B. Aja, L. de al Fuente, E. Artal Univ. Cantabria, Santander	Bengt Gustafsson, CEO Microwave Technologies AB
Circular Monopole & Dipole Antennas for UWB Radio Utilizing a Flex-Rigid Structure M. Karlsson, S. Gong Linköping Univ.	Further enhancement of Load pull simulation technique to study non linear effects of LDMOS in TCAD A. Kashif, T. Johansson, C. Svensson, T. Arnborg, Q. Wahab Linköping Univ., Infineon, FOI	High Efficiency using Optimized SOI Substrates L. Vestling, O. Bengtsson, K.-H. Eklund, J. Olsson Uppsala Univ., Univ. Gävle	Open debate and discussion with auditorium
Design, Manufacture and Test of Eleven Feed for 1-13 GHz J. Yang, I. Karlsson, X. Chen, P.S. Kildal Chalmers	GaN device and MMIC development at Chalmers M. Fagerlind, M. Südow, K. Andersson, A. Malmros, P.Å. Nilsson, H. Zirath, N. Rorsman Chalmers	Spin Torque Oscillator Simulations and Circuit Design Y. Zhou, S. Srinivasan, J. Persson, J. Åkerman Royal Institute of Technology	
1430-1500 Coffee			
SILVER SPONSORS: ROHDE & SCHWARZ National Instruments			
1500-1600 SESSION V Runan Chairman: Arne Alping, Ericsson			
1500 Invited speaker Industrial aspects of 100 Gb/s optical communication Bengt-Erik Olsson Ericsson Research			
1530 All-Optical Waveform Sampling with TeraHertz Capacity M. Westlund, P.A. Andrekson, H. Sunnerud Chalmers, Picosolve Inc.			
High Speed 1.3 μm VCSELs for FTTH and RoF P. Westbergh, E. Söderberg, J.S. Gustavsson, P. Modh, A. Larsson, Z.Z. Zhang, J. Berggren, M. Hammar Chalmers, Royal Institute of Technology			
1600 Closing Remarks Jan Grahn, Chalmers; General Chairman GHz Symposium 2008 Henrik Sjöland, Lund University: Next GHz Symposium arranger			
1630-1730 Visit (optional) MC2 Cleanroom or Microwave Labs, Chalmers (www.chalmers.se/mc2)			

560 GHz f_t , f_{max} operation of a refractory emitter metal InP DHBT

Erik Lind*

Solid State Physics, Lund University
Lund University, Sweden
Erik.Lind@ftf.lth.se

* work performed in part while at UCSB

Adam M. Crook, Zach Griffith, Mark J. Rodwell
ECE Department, University of California
Santa Barbara, CA, USA

Abstract—We present results of a hybrid dry/wet-etched type I InGaA/InP DHBT using a refractory emitter metal. Simultaneously high f_t and f_{max} of 560 GHz is obtained, with a breakdown voltage BV_{ceo} of 3.4V.

I. INTRODUCTION

Scaling theory [1] of HBTs indicate that a 2:1 increase in bandwidth requires a 4:1 reduction in emitter and collector widths – for THz operation this requires emitter widths below 125nm. Traditional lift-off techniques and wet etching techniques used for triple-mesa HBTs are difficult to *reliable* scale below 300 nm emitter widths. We have developed a hybrid dry/wet etch technique that reliable scales to emitter widths below 250nm. First results on a 22nm base thickness, 70 nm collector thickness with ~200 nm emitter width produced record simultaneous f_t and f_{max} of 560 GHz [2].

II. FABRICATION

The epitaxial material was grown on 4" S.I. InP wafers at commercial vendor IQE. The fabrication starts with a blanket sputtered deposited $Ti_{0.1}W_{0.9}$ film, which is subsequently patterned using a SF_6/Ar dry etching. Using the emitter metal as mask, the emitter is dry etched in a Cl_2/N_2 plasma, stopping just short of the base. A InP wet etch is then used to clear the $In_{0.53}Ga_{0.47}As$ base. The transistors are finished using self aligned base ohmics, forming a triple-mesa transistor. A cross-section SEM image is shown in Fig. 1. Emitter junctions with widths down to 200 nm could controllably be fabricated, showing a substantial improvement over fully wet etched processes.

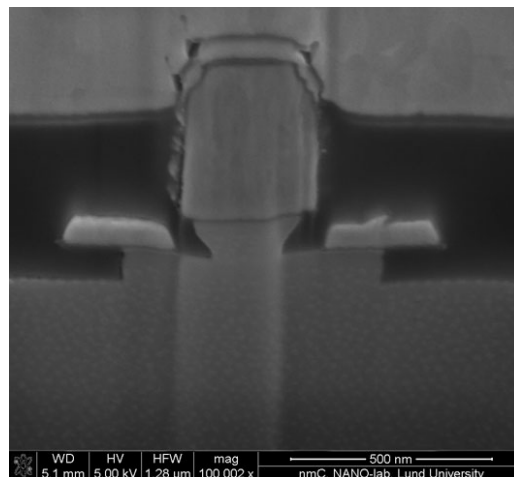


Figure 1. Cross section view (52° tilt) of a DHBT

III. MEASUREMENTS & CONCLUSIONS

The transistors were characterized from DC-67 GHz. The DC current gain was ~ 25 . The Breakdown voltages were $BV_{ceo} \sim 3.4V$, and $BV_{cbo} \sim 3.6 V$, limited by band-to-band tunneling. For devices with emitter widths of 200 nm, a simultaneous extrapolated f_t and f_{max} of 560 GHz was obtained, which is the first report of a device with *both* f_t and f_{max} above 500 GHz. Peak f_t was 600 GHz for a device with lower (430 GHz) f_{max} .

ACKNOWLEDGMENT

This work was supported by the DARPA SWIFT program and a grant from the Swedish Research Council.

REFERENCES

- [1] M. Rodwell et al., IPRM 2007, pp. 9-13
- [2] E. Lind et al., DRC 2007, Late News