

ONR D&I Electronics Technology Programs Report

Contract Number: N00014-06-C-0054

Performer: HRL Laboratories

Contract PI: Jeong Moon

Program Period (Baseline): 2/23/06 – 12/31/08

Reporting Period: Sep, 2008

Program Status:

One of the D&I program goals is to develop greatly improved field-plated MMW GaN HEMT devices with high f_t/f_{max} , which will improve gain/PAE and output power of GaN HEMT MMIC PAs simultaneously. The 6-wafer MMW GaN MMIC lot is competed with the front-side processing and waiting for the back-side processing.

Key Accomplishments or milestones:

- 1) Figure 1 shows optical photographs of MMW GaN MMIC circuits in the fab currently.

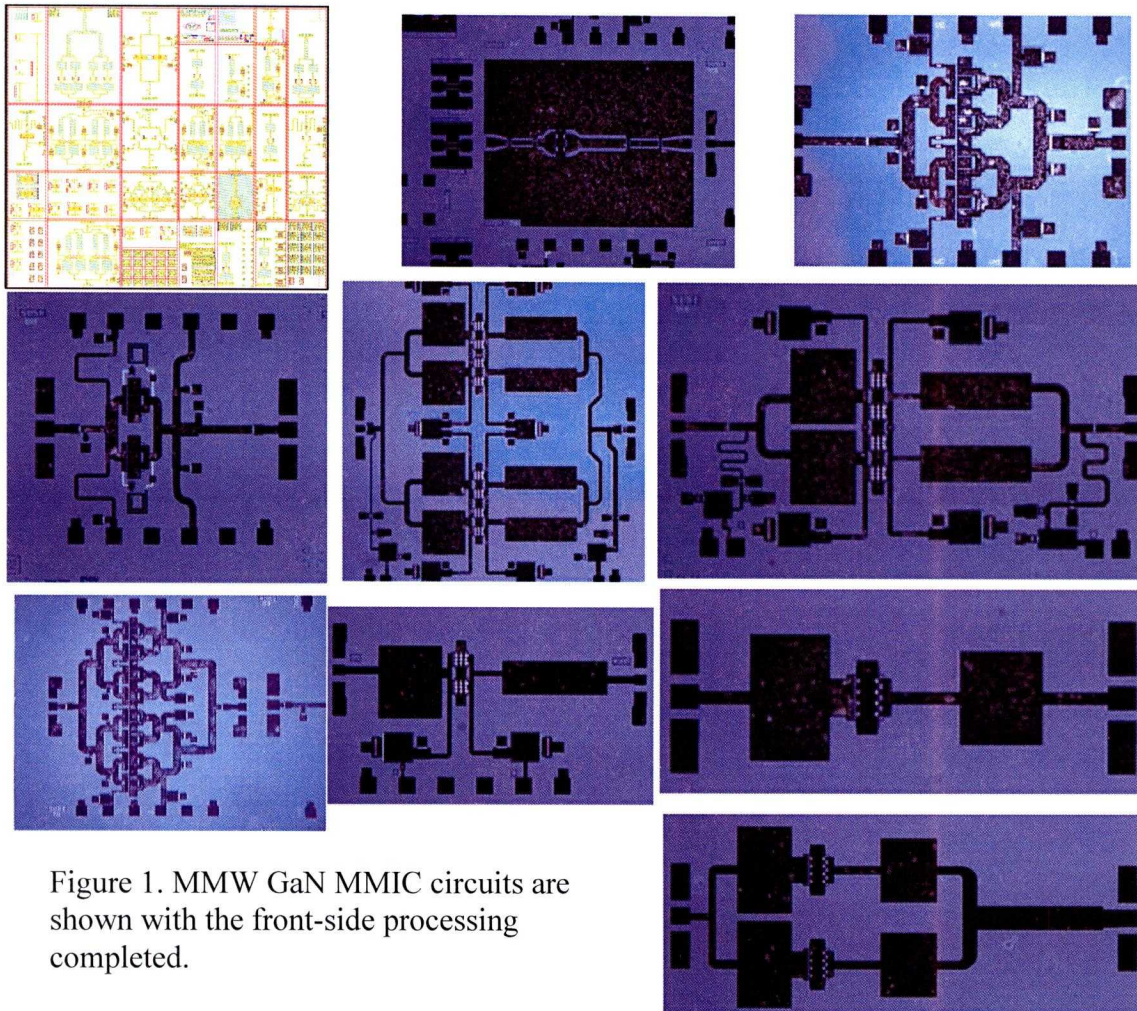


Figure 1. MMW GaN MMIC circuits are shown with the front-side processing completed.

All the PCM devices are tested and characterized in terms of DC and RF. Table 1 shows measured $2 \times 100 \mu\text{m}$ PCM devices after the front-side processing complete, in

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE SEP 2008		2. REPORT TYPE		3. DATES COVERED 23-02-2006 to 31-12-2008	
4. TITLE AND SUBTITLE ONR D&I Electronics Technology Programs Report				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) HRL Laboratories,3011 Malibu Canyon Road,Malibu,CA,90265-4797				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 6	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

comparison to those from the EEHEMT device model used for MMW GaN MMIC circuits.

Table1: Summary of GaN37 wafers in processing

Wafer	Idss/Imax (A/mm)	I _{min} (mA/mm) @ V _{gs} = - 6V	Peak gm (mS/mm)	V _{po} (V)	F _t (GHz)	Status
Design Target	0.78/1.01	<0.0001*	377	-2.9	55	EEHEMT model
G544	1.01/1.16	1.2	325	-3.88	50	Backside processing
G552	--	-	-	-	-	Broken
G632	0.8/1.0	0.25	366	-2.4	52	Backside processing
G634	0.85/1.08	0.2	414	-2.3	55	Backside processing
G645	0.86/1.07	0.1	391	-2.5	54	Backside processing
G646	0.91/1.11	0.1	385	-2.7	53	Backside processing

- I_{max} is defined at V_{ds} = 1 V at this time
- I_{min} was measured at V_{ds} = 10 V and V_{gs} = -6 V, well below the V_{pinchoff}.
- F_t was measured at V_{ds}=10 V and V_{gs} at peak gm.
- *The EEHEMT model is not well established below the pinch-off voltage.

- 2) Single-stage CPW circuits are characterized in terms of gain and bandwidth, and compared with the simulation. Figure 2 shows the comparison plot. The bandwidth is wider than that of simulated. It is attributed to a change in the input match. With the backside processing complete, we will have more results to compare with.

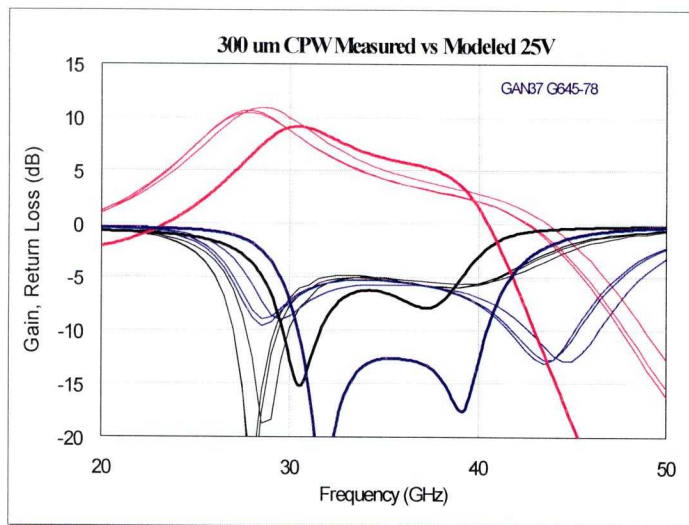


Figure 2. Measured (thin lines) and simulated (thick lines) s-parameters of the single-stage CPW MMICs are shown with 25 V_{ds} and 200 mA/mm. The gain and bandwidth are not sensitive to V_{ds} over V_{ds} = 20 – 28 V, and I_{ds} = 200 -70 mA/mm.

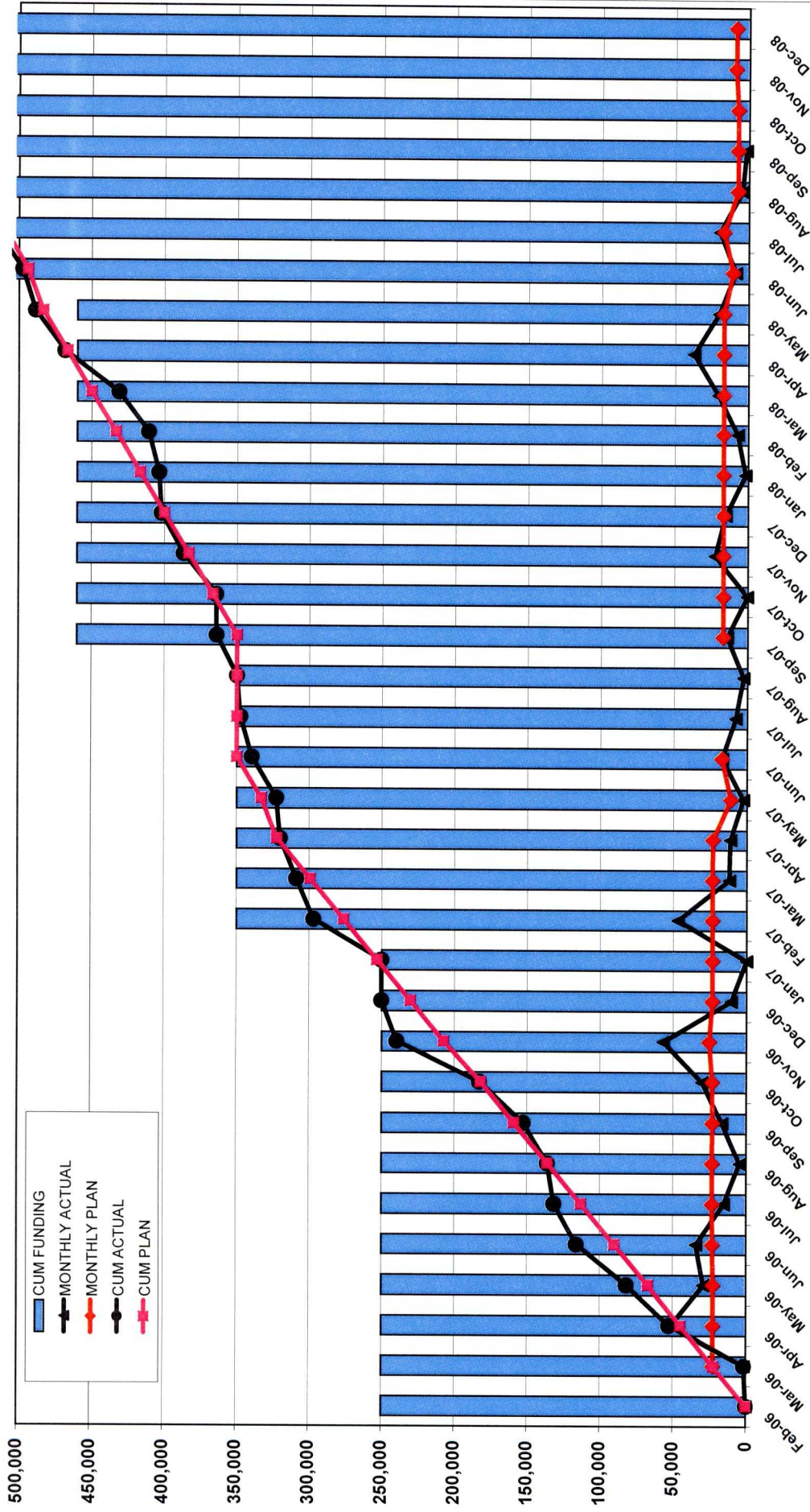
Objectives for next month:

- 1) Complete the MMW GaN MMIC lot.

Budget summary: The available funding to be spent would be ~\$60 K with a fee in the contract, which has a total funded amount of \$ 550 K.

Prog Mgr J. Moon	Award: 549,945	Funding: 549,945	Expenditures: 522,764	Balance: 27,181
Contract No N00014-06-C-0054	Reporting Period From: 9/1/08	Thru: 9/26/08		
Contract Type: CPFF	HRL PROPRIETARY			
Report Description: FUNDS EXPENDITURE GRAPH				

BC57 - GaN HEMTs for Simultaneous High Power and High PAE MMW Operation



					HRL PROPRIETARY				
Contract No Contract Type: HRL Ref#: 05031 BC57	N00014-06-C-0054 CPFF	Thru Mod:	Monthly Funds & Labor Hour Expenditure Report	Preparation Date: Reporting Period From: Period of Performance: Funding: \$ 549,945	10/6/08 9/1/08 2/23/06	Thru: Thru: Thru: Thru:	9/26/08 12/31/08		
A	B	C	D	E					
ORIGINAL NEGOTIATED CONTRACT	LATEST NEGOTIATED CONTRACT CHANGES	REPORTING PERIOD EXPENDITURES	CUMULATIVE EXPENDITURES	ESTIMATE AT COMPLETION					
A1 MAN HOURS	B1 MAN HOURS	C1 MAN HOURS	D1 MAN HOURS	E1 MAN HOURS					
A2 DOLLAR AMOUNT	B2 DOLLAR AMOUNT	C2 DOLLAR VALUE	D2 DOLLAR VALUE	E2 DOLLAR VALUE					
SMTS2	27	2,239	15	1,286	0	0	27,012	42	3,525
SMTS1	466	29,550	419	25,865	1	27	43,262	885	55,415
MTS	666	35,400	174	9,682	0	0	6,658	840	45,082
TE	645	24,896	382	15,436	8	464	30,697	1,027	40,332
GE	0	0	0	0	0	0	111	0	0
CA	23	1,022	12	550	0	0	2,687	35	1,572
PA	0	0	0	0	0	0	358	0	0
Total Hours & Dollars	1,827	93,107	1,002	52,819	9	491	110,785	2,829	145,926
LAB ALLOCATION						212	22,362		
OVERHEAD		152,384		85,161		1,103	213,400		237,545
TOTAL LABOR & O/H		245,491		137,980		1,806	346,547		383,471
MATS & PARTS		37,364		25,482		0	69,660		62,846
TRAVEL EXPENSES		1,864				0	3,759		1,864
ODC,SUB		0				0	261		0
SUB-TOTAL COSTS		284,719		163,462		1,806	420,227		448,181
G&A		30,025		16,822		200	47,661		46,847
COST OF MONEY		8,466		4,374		373	14,943		12,840
TOTAL COST		323,210		184,658		1,633	482,831		507,868
FEE / PROFIT @ 8.5%		26,753		15,324		171	39,933		42,077
TOTAL CPFF		349,963		199,982		1,804	522,764		549,945
P.O. Commitments							0		
TOTAL COMM & EXP				1,804		1,804	522,764		
Distribution authorized to DoD Components only.									
Destroy by any method that will prevent disclosure of contents or reconstruction of the document.									

Dollars

HRL PROPRIETARY

MONTH	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07	May-07
MONTHLY PLAN	-	22,315	22,356	22,333	22,977	23,001	23,061	22,924	23,038	25,183	23,014	22,983	23,024	23,019	22,956	10,808
CUM PLAN	-	22,315	44,671	67,004	89,981	112,982	136,043	158,967	182,005	207,188	230,202	253,185	276,209	299,228	322,184	332,992
MONTHLY ACTU	-	1,432	51,215	29,132	34,270	15,422	4,525	16,603	30,176	56,791	10,489	-	46,797	11,952	11,251	2,474
CUM ACTUAL	-	1,432	52,647	81,779	116,049	131,471	135,996	152,599	182,775	239,566	250,055	250,055	296,852	308,804	320,055	322,529
CUM FUNDING	249,963	249,963	249,963	249,963	249,963	249,963	249,963	249,963	249,963	249,963	249,963	249,963	349,963	349,963	349,963	349,963

Hours

MONTH	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07	May-07
MONTHLY PLAN	0	120	121	120	120	120	121	120	121	120	120	120	120	120	120	61
CUM PLAN	0	120	241	361	481	601	722	842	963	1083	1203	1323	1443	1563	1683	1744
MONTHLY ACTU	0	8	134	169	179	35	26	98	160	312	51	101	111	71	62	8
CUM ACTUAL	0	8	142	311	490	525	551	649	809	1121	1172	1273	1384	1455	1517	1525