METDA
GaN Reliability Evaluation Report

Date：2014.10.01

METDA

Contents

- Introduction
- High Temperature Storage Lifetime of Components
- High Temperature Reverse Bias Lifetime of Capacitors and Devices
- DC Steady-state Lifetime of Devices
- MTTF Lifetime Estimate of Devices
- Conclusion

METDA

Introduction

We generated the MODEL W1220 for evaluating the GaN processing reliability through designs of capacitors, impedance and inductance with different dimension/structure. We took 10 batches of wafer processing through series of High Reliability Test like High Temperature Storage, High Temperature Reversebias, DC Stable State and MTTF Lifetime to get the final GaN Processing Reliability Test Result.

The standards we adopted were: JEP118 (JEDEC Standard), GJB128A (Chinese National Military Standard), GJB33A (Chinese National Military Standard), etc.

METDA

Introduction

GaN Power MMIC Standard Evaluation Process

1. Normal Temperature Power Output Testing.
Test to evaluate Power Output, Efficiency, Bandwidth and Gain under normal Temperature.

2. Small Signal Characteristics Testing.
Test to evaluate Small Signal VSWR, Gain, Phase Linearity

3. High and Low Temperature Testing
Test to evaluate Changes of Power Output, Efficiency and Current under High and Low Temperature.

4.Voltage Scanning Testing
Test to evaluate Performance of Output Power and Efficiency under different voltage, coordinating with tests of other application.

METDA

Introduction

GaN Power MMIC Standard Evaluation Process

5. Input Power Scanning Testing
Test to evaluate Characteristics of Power Output under different Input Power. It reflects the Compression characteristics of different frequency points.

6. Duty Cycle Scanning Testing
Test to evaluate Performance of Power Output and Efficiency under different Duty Cycle, coordinating with tests of other application.

7. Thermal Resistance Testing
Test to evaluate Thermal Characteristics test when devices are in DC and Pulse mode.

8. Accelerated Life Testing
Test to evaluate Product Long time Operation Lifetime

METDA

Introduction

Testing Condition

1. Capacitor Dimension： 25*25μm^2, 50*50μm^2, 100*100μm^2, 100*200μm^2.

Impedance Dimension： 25μm*50μm, 50μm*50μm, 100μm*50μm.

Inductance Dimension (wire width* distance* cylinder number):8μm*6μm*4.

Active Device Gate Width: 10*125μm.

Introduction

Testing Condition

2. Testing Condition of High Temperature Storage: 285 ℃ , 168hours. It proves the reliability of capacitors, impedance, inductance and active devices under High Temperature Condition.

3. Testing Condition of High Temperature Reversebias: Capacitor 60V/1512hours, Active Devices 48V/-6V/1008hours. It proves the reliability of capacitors, impedance, inductance and active devices under High Temperature and Electricity on Condition.

4. Testing Condition of DC Stable Stage Lifetime: 28V/200mA/150 ℃, it is for testing the reliability of Active Devices under long time working condition.

5. Testing Condition of MTTF Lifetime: 275/250/225 ℃, it is for testing the estimated lifetime under certain Junction Temperature.

METDA

High Temperature Storage Lifetime of Components

Evaluated components: capacitors, resistors, inductors

NO.	Component	Conditon	Lifetime	Result
1	Capacitor	285℃，air，168h	>168h	Variation : Capacitance and resistance decreases. Variable Quantity: 3-5%
2	Resistor			
3	Inductor			
4	Devices	285℃，air，168h	>168h	Variable Quantity： 1）Leakage current of （gate）source and drain increases 1-2 times. 2）Saturated current decreases 5-13%.

Conclusion： High temperature(285℃) storage lifetime of capacitors, resistors, inductors, devices is more than 168h. Estimated 150℃ storage lifetime is more than 10^6h.

High Temperature Reverse Bias Lifetime of Capacitors and Devices

Evaluated Components： capacitors, devices

NO.	Component	Conditon	Lifetime	Result
1	Capacitors	150℃，60V，air，1512h	>1512h	Variation：Capacitance decreases. Variable Quantity: 3%
2	Devices	150℃，48V/-6V，air，1008h	>1008	Variation ： Max current increases. Variable Quantity : 2%

Conclusion： High temperature(150℃) reverse bias of capacitors and devices is valid within 1008h、1512h. Estimated 150℃ reverse bias lifetime is more than 10^6h. The 150℃ Test is Primary/First test, without Passing it, no further High Temperature test will be taken.

METDA

Devices DC Steady-state Lifetime

Evaluated components： devices

NO.	Components	Condition	Lifetime	Result
1	Devices	150℃，1.25mm， 28V/200mA，air，1000h	1000h	Variable quantity of max current：2%

Conclusion： DC steady-state lifetime at 150℃ of devices is more than 1000h.

The 150℃ Test is Primary/First test, without Passing it, no further High Temperature test will be taken.

MTTF Lifetime Estimate of Devices

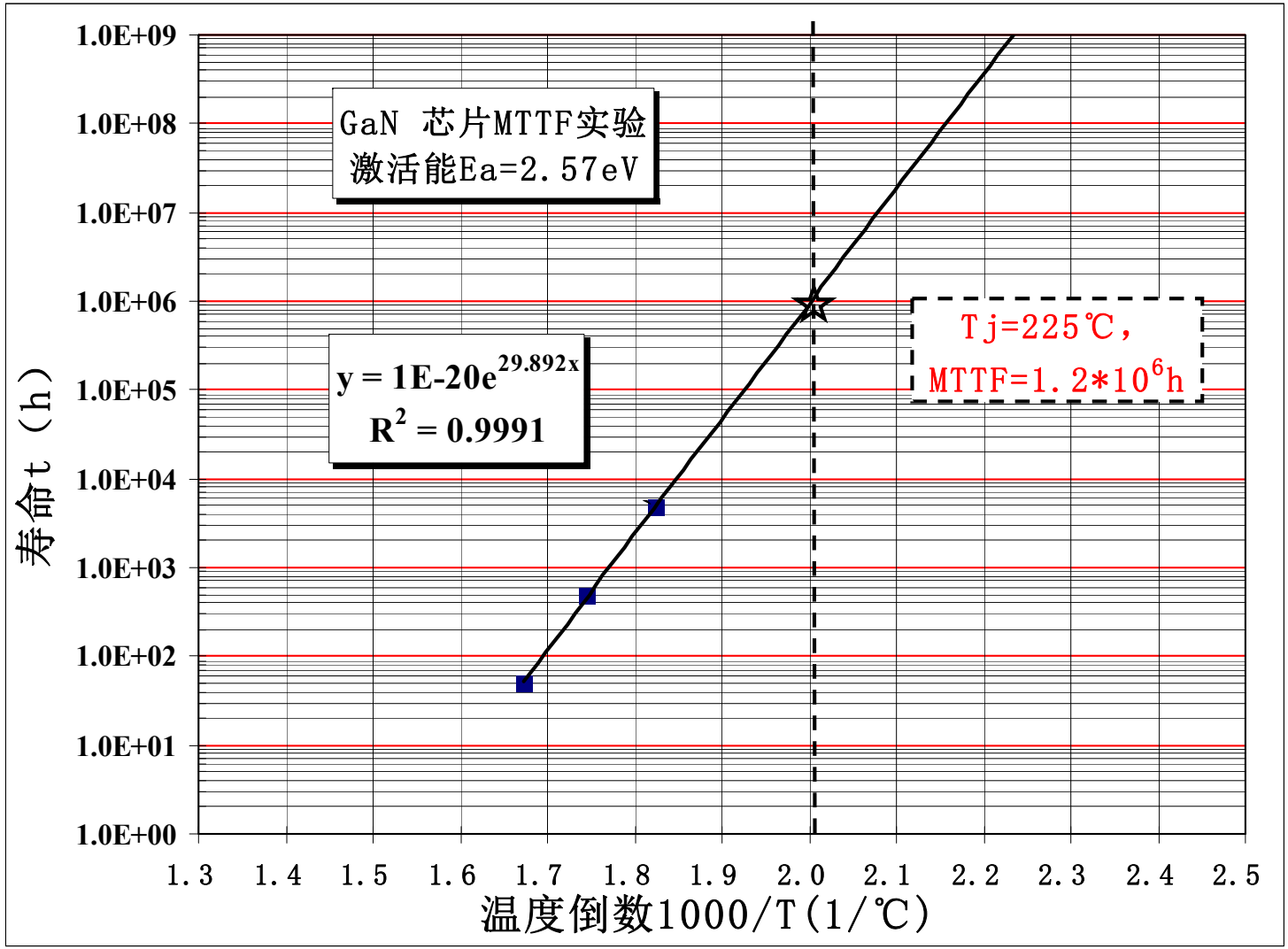
Evaluated Components：Devices

NO.	Components	Condition	Lifetime	Result
1	Devices	Junction temp: 325℃，1.25mm，28V/120mA，air，Variation of max current: 20%	50h	Failure mode：1）Max.（saturated）current decreases. 2）Source and drain resistance increases. 3）Break-over voltage of gate decreases.
2	Devices	Junction temp: 300℃，1.25mm，28V/120mA，air，Variation of max current: 20%	500h	
3	Devices	Junction temp: 275℃，1.25mm，28V/120mA，air，Variation of max current: 20%	4800h	
4	Devices	Junction temp: 225℃，1.25mm，28V/120mA，air，Variation of max current: 20%	Activation energy 1.60eV MTTF= $2.2*10^6$h	

Conclusion：MTTF of devices (junction temp: 225℃) reaches $1.2*10^6$h.

MTTF Lifetime Estimate of Devices

Devices Typical Arrhenius Curves



Conclusion

1） High temperature(285℃) storage lifetime of capacitors, resistors, inductors and devices is more than 168h. Estimated lifetime at 150℃ is more than 10^6h.

2）High temperature(150℃) reverse bias of capacitors and devices is valid within 1008h, 1512h. Estimated 150℃ reverse bias lifetime is more than 10^6h.

3） Conclusion：The Primary Test of DC steady-state lifetime at 150℃ of devices is more than 1000h.

4）Conclusion：MTTF of devices (junction temp: 225℃) reaches $1.2*10^6$h.

METDA