

GaN Reliability – Where We Are and Where We Need to Go

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AlGaN/GaN High Electron Mobility Transistors (HEMTs) offer significant performance advantages over competing technologies for RF applications, but lingering questions about long term reliability persist. This paper will discuss where the state of GaN reliability is and offer suggestions on where the industry needs to go to address remaining reliability concerns.

In the early days of GaN HEMT development, dc and RF performance was often benchmarked on the initial test because subsequent measurements frequently yielded degraded results. Lifetimes could be measured in real time as devices degraded in minutes or hours. As the technology matured, many groups were able to demonstrate continuous on-wafer operation, both dc and RF, for 100s and even 1000s of hours with minimal change in performance. At this point, accelerated life tests (ALT) of fixtured devices and standard evaluation circuits (SECs) were initiated. Numerous accelerated life test results have been reported over the years and pertinent conclusions will be described and summarized (Figure 1). In addition to an analysis of reported ALT data, the current understanding of dominant failure modes and mechanisms will be discussed. Given the critical role accelerated life tests play in the assessment of a technology's long term performance a brief description of accelerated life test methodology and Arrhenius analysis will be presented.

AFRL has been engaged in GaN reliability assessments for over a decade in support of programs like the Defense Advanced Research Projects Agency (DARPA) Wide Band Gap Semiconductors for RF Applications (WBGs-RF) and the Defense Production Act (DPA) Title III Investments in Gallium Nitride Semiconductor Manufacturing Readiness. This activity has allowed AFRL and the other service laboratories (NRL and ARL) to independently assess the reliability of program deliverables as well as have insight into the ongoing reliability assessments conducted by performers.

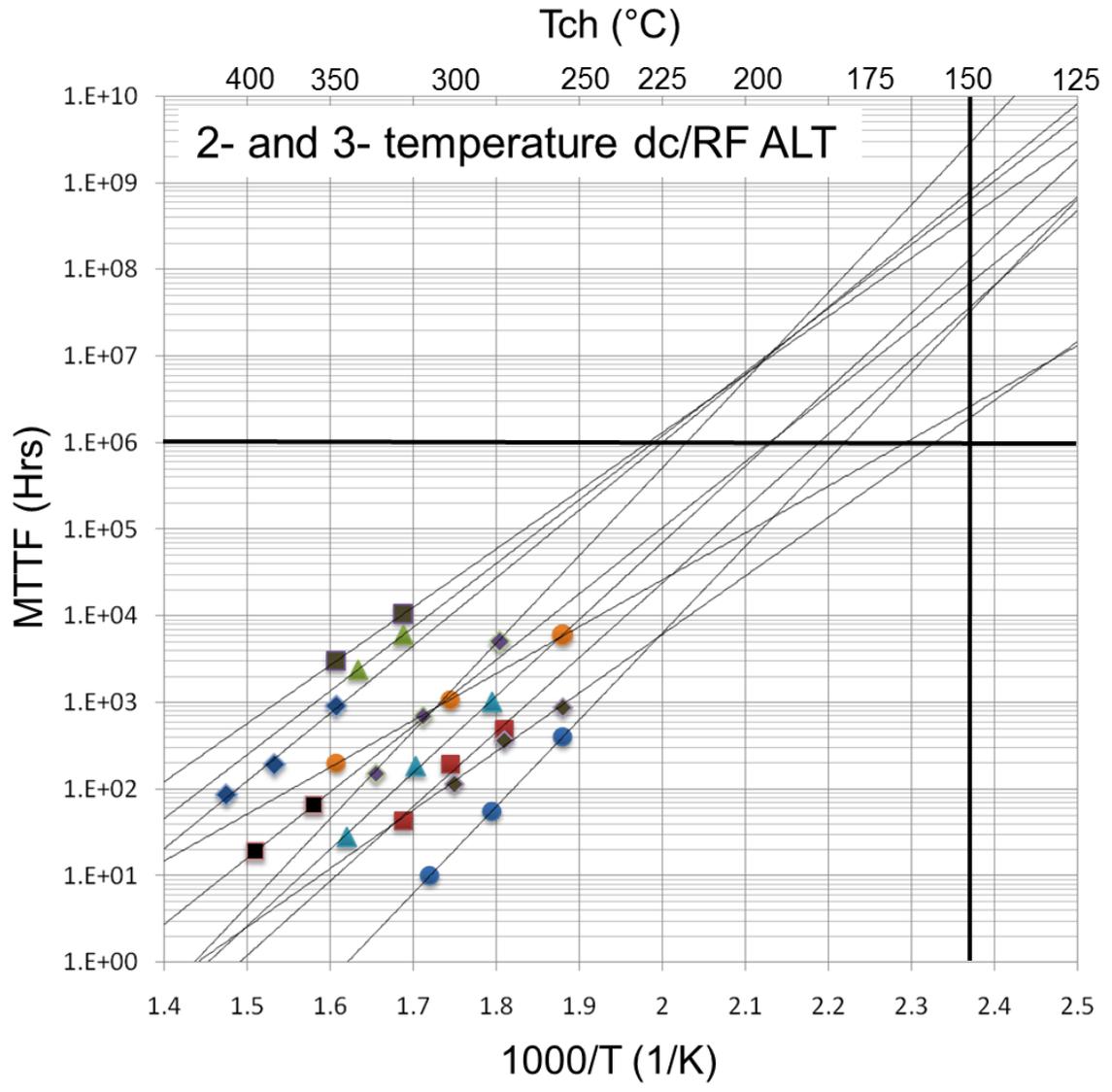


Figure 1: Snapshot of reported accelerated life test Arrhenius data.