Instabilities in GaN based FET Devices - Nature and Alternative Structures

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GaN is the first highly polar semiconductor material used in electronics. And the dipole nature of the polarization field may interfere with the operation of unipolar structures like FETs, causing polarization field induced instabilities.
Indeed, the RF large signal current collapse and the RF power slump have been plaguing GaN based HFETs in the past severely. This effect has been observed over a wide range of time and frequency, making it particularly difficult to identify the source. However, in many cases it can be linked to polarization induced charge instabilities. This is a phenomenon not observed in conventional III-V heterostructures and has to be considered carefully in the design of these device structures.

Acting on the device performance are the field induced image charges to the bonded polarization charges, especially at hetero-interfaces. Their influence can be identified in the buffer layer as well as in the active layer configuration.

At first, the polarization related instability phenomenon will be described [1,2] and power lag characteristics in AlGaN/GaN HFETs discussed. Then, alternative heterostructures, namely the InGaN channel FET [3] and AlGaN double barrier FET structure [4] are introduced, where these instabilities have not been observed. These structures make use of the novel concept of doping screening of the polarization field [5].

References

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