The DTLS technique and its use in the analysis of III-nitrides heterostructures for HEMT applications

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Deep Level Transient Spectroscopy is a well known technique for the observation and characterization of deep levels in semiconductor materials. DLTS is a capacitance transient thermal scanning technique that operates in the MHz range.

The DLTS technique has the advantage of being sensitive and relatively easy to analyze and with respect to other known deep level analysis techniques. Moreover it is spectroscopic, which means it can differentiate between different deep centers inside the same sample, and can differentiate between majority and minority carrier traps.

However, a DLTS sample needs to have a good rectifying junction, which can create technical difficulties in some type of samples.

The DLTS technique can give information on the energy and capture cross section of the levels present, their number and their concentration inside a semiconductor sample. As deep levels can control the non-radiative lifetime of carriers in a semiconductor, their characterization is an essential step in the fabrication process of new material and devices.

III-nitrides are a very promising class of compounds consisting of alloys group III elements nitrides (GaN,InN and AlN). Their main characteristics are the tunable band gap in a wide range covering the whole solar spectrum, and their very similar lattice parameter, which allows for a relatively easy growth of heterostructures.

Another important characteristics of III-nitrides on GaN heterostructres is the high polarization field at the interface that allows the formation of a 2-D free electron gas at the interface. These characteristics are advantageous in the fabrication of High Electron Mobility Transistors based on III-nitrides heterostructures.

As heterostructures often presents defects which controls their transport characteristics, the DLTS technique is invaluable in determining the nature and concentration of these centers to have a feedback on the growth process and to correlate the presence of these centers to the performance of HEMT devices.