INTRODUCTION

Undoubtedly the most important material in today's microelectronics industry is silicon (Si). Its dominant position is mainly due to the unique physicochemical properties of its oxide, in addition raw material is very abundant. In today's market gallium arsenide (GaAs) has begun to make a place for itself not by replacing silicon but by complementing it in specific applications.

The most important advantages offered by GaAs, are the high mobilities of electrons, which can make GaAs devices very fast and semi insulating substrate which reduce parasitic capacitances and hence increase the frequency range of operation. There can be little doubt that the place GaAs occupies owes much to the development of GaAs Field Effect Transistors (GaAsFET's). Although other devices such as High Electron Mobility Transistor (HEMTs), Heterojunction Bipolar transistors (HJT's), Light Emitting Diodes (LEDs) are beginning to find increasing use. Some of them (LEDs) actually dominate specific applications since there is no substitute material.

The GaAs integrated circuit (GaAs ICs) are now following the step of GaAs FETs. Tremendous progress has been made in the application of GaAs FETs in Monolithic Microwave Integrated circuits (MMICs) extending down in DC (KHz) and up to milimeter wave frequencies (MHz).

Yet, in spite of these advantages over silicon, an important inherent deficiency is the unsatisfactory nature of native oxides (of Ga and As) as dielectrics or passivating layers. The deep levels (impurities or defects) which are introduced during the preparation or by some added elements such as chromium or oxygen are known to have anomalous effects on MESFET performance. An example is the backgating which is the reduction of device current caused by a negative voltage applied to the semi-insulating substrate. This is due to the deep traps near the substrate-channel-interface or in substrate itself. There have been some attempts to reduce this effects. Among these is the growth of a high purity epitaxial buffer layer between the channel and the substrate, and by implantation of Proton [17], oxygen [18] in the substrate. These have reduced but not eliminated it.

As essential step to eliminate or reduce these effect is to correctly identify defect responsible for it.

The Aim of this work is to make a contribution by identifying the defect type responsible for this effect and propose some solutions.

Thesis structure

This thesis is divided into four chapters. In chapter 1 we present a general introduction to gallium arsenide and the operation and DC characteristics of GaAs FETs. The deep levels are discussed in chapter 2, where we begin with a general introduction to deep levels and the materials in which they are of particular importance before describing their interaction and their characterization using the technique called Deep Level Transient spectroscopy (DLTS).

An overview of numerical simulation is presented in chapter 3. Chapter 4 presents the results of simulation and their interpretation using estabilished methods and new ones. Finally the conclusions and suggestions for further work are presented at the end of this work.