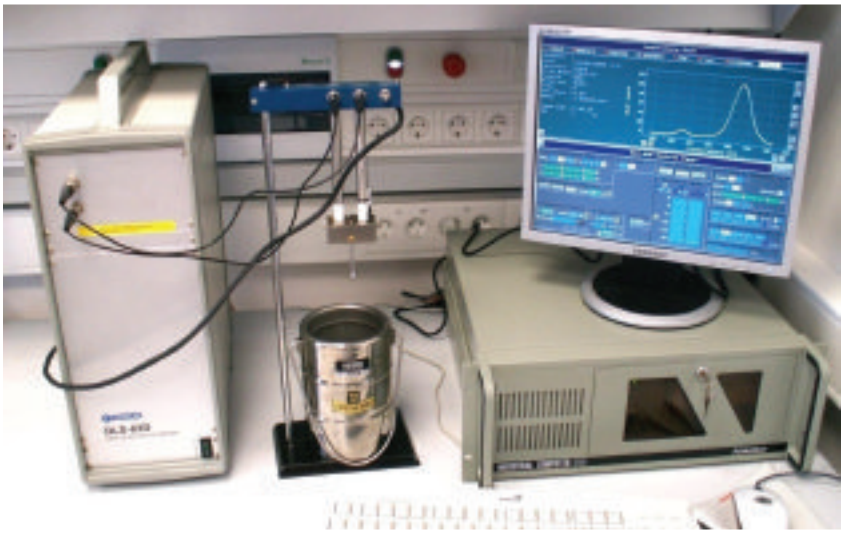
High quality LPE GaAs power diodes…

…with DLTS method…

High frequency, high power and high temperature semiconductor devices have been a challenge to device engineers since their first appearance in the middle part of the last century. Most conventional semiconductor power diodes are almost exclusively formed using silicon (Si). Due to the relative maturity of the use of this semiconductor material, the performance of conventional Si power diodes to carry high temperatures, frequencies, currents, and block high voltages is closely approaching the theoretical limit for Si. There are many applications for power diodes that require the ability to carry extra high currents and blocking voltages, like motor control or power supply systems, lighting ballast circuits, power transmission and generation systems, utility power conversion equipments, and many other applications. Unfortunately, the overall performance of power diodes manufactured from Si is poor for these currents or blocking voltage ranges, and the lack of such power diodes represents the primary limitation in realising circuits and systems for these applications. Today semi-wide band-gap material like GaAs seems to partly fulfil this demand of industrial solutions; that is until the wide-band gap materials-based solution comes alive.

GaAs high voltage p-n junction-based structures with low doped wide enough base regions can be manufactured today using both LPE (Liquid Phase Epitaxy) and CVD (Chemical Vapour Deposition) technologies. Unfortunately, the CVP technology principally limits itself with thickness of 40 microns for low doped base region. This is extremely strong limitation for the development of high voltage and high frequency power semiconductor diode structures. For the LPE technology, no such limit exists. The new approach for the manufacturing of commercial high-speed power p+-p-i-n-n+ GaAs structures using the LPE technology has been introduced and obtained by the Estonian company Clifton Ltd together with the scientists from the Department of Electronics, Tallinn University of Technology, Estonia.



The measurement station

The LPE technology has some tricky sides defining the quality of the LPE epilayer. Namely, the concentrations of deep level impurities in the LPE epilayer have a strong influence on the main electrical characteristics of devices including these LPE epilayers. So, the control of the concentration of deep level impurities in LPE epilayers can predict the quality of the GaAs LPE diodes. Deep Level Transient Spectroscopy (DLTS) is very useful in detecting small concentrations of impurities and defects exceeding the sensitivity of chemical analysis techniques such as SIMS and Auger spectroscopy. The necessity of DLTS as a routine fabrication process monitoring tool can be inferred from the consequences of having material with unintentional impurities or defects. On the base of DLTS technology the semiconductor research group from the Department of Electronics of Tallinn University of Technology has initiated the procedure and has developed the methodology for the detection and control of the deep impurity levels in GaAs epilayers manufactured by LPE process. The target of the research is to avoid the anomalies in the concentration of deep level impurities during the GaAs LPE growth process of epilayers, and consequently to increase the yield of high quality GaAs LPE epi-wafers for manufacturing the high-speed GaAs power diodes.

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