Development of the Laplace Deep Level Transient Spectroscopy System in the Institute of Physics, Polish Academy of Sciences

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Laplace DLTS method has been derived from conventional Deep Level Transient Spectroscopy method introduced by D. V. Lang [1]. His work based on p-n junctions and Shottky barrier characterization techniques developed in 1960s and early 1970s. Initially DLTS has been used for characterization of deep level defects in crystalline semiconductor samples. The measurement setup based on measuring and processing capacitance transients of a reverse polarized Shottky/p-n diode subject to electric impulse excitation.

The method proved to be an invaluable tool for fast, easy and cheap characterization of semiconducting samples. However it soon became obvious that it has some serious drawbacks. First and foremost it is prone to instrumentation errors resulting in relatively poor energy resolution. There was a lot of work put during the next 20+ years into refining the method to improve the resolution, to no avail. After moving from analog world to the digital one with the advent of fast A/D converters and powerful enough desktop computers several new approaches emerged. The most promising being applying inverse Laplace transform to capacitance transients to separate exponential components of the signal. In 1989 Hawkins at al. built low noise digital DLTS system at University of Manchester (UMIST) to be used as easy to use defect analyzer. In the next year Leszek Dobaczewski from the Institute of Physics, PAS in Warsaw, took an appointment in Manchester and a year later created the first working defect analyzer applying CONTIN [2] software to do inverse Laplace processing. The first *Laplace DLTS System* was born.

With the help of an EU grant (*Copernicus* program) a joint team of scientists and engineers from UMIST, IFPAN, Institute of Physics in Vilnius and University of Freiburg created the first complete LDLTS measurement system, finished in 1996.

In this work I will show the very basic idea of DLTS and LaplaceDLTS showing their advantages and disadvantages, the minimal hardware setup necessary to perform (Laplace) DLTS measurements, then present properties of the *LaplaceDLTS System* as developed in IFPAN. I will show how and when it can be used and how it is applied to measurements other than standard electrical sample characterization and systems other than simple Shottky/p-n diodes.

At the very end I will also present hardware components designed and manufactured in IFPAN for the purpose of advanced LDLTS and related techniques, of which some can be used in other experimental setups.

For more technical details and comprehensive list of publications on the technique and its use please refer to our web site [3].

[1] D. V. Lang, *J. Appl. Phys.* **45**, 3023 (1974).
[2] S. W. Provencher, *Comput. Phys. Commun.* **27** (1982), p. 213
[3] www.laplacedlts.eu