Université de Biskra
Département des Sciences de la Matière

Faculté des Sciences Exactes et SNV

1 MASTER- Caractérisation des Semi-conducteurs

TD 05 : DLTS Technique

Exo 01

Proof the following equations related to the deep level transient spectroscopy DLTS theory:

1.

$$n_T(t) = N_T e^{-e_n t}$$

2.

$$e_n(T) = K_n T^2 \sigma_n e^{-\frac{E_C - E_T}{kT}}$$, with $$K_{n(p)} = \frac{2(2\pi)^{3/2} 3^{1/2} m^*_{n(p)} k^2}{h^3}$$

3.

$$C(t) = C(\infty)[1 - \frac{N_T}{2N_D} e^{-t/\tau}]$$, with $1/\tau = e_n(T)$

4.

$$\tau_{max} = \frac{t_2 - t_1}{ln(t_2/t_1)}.$$

5.

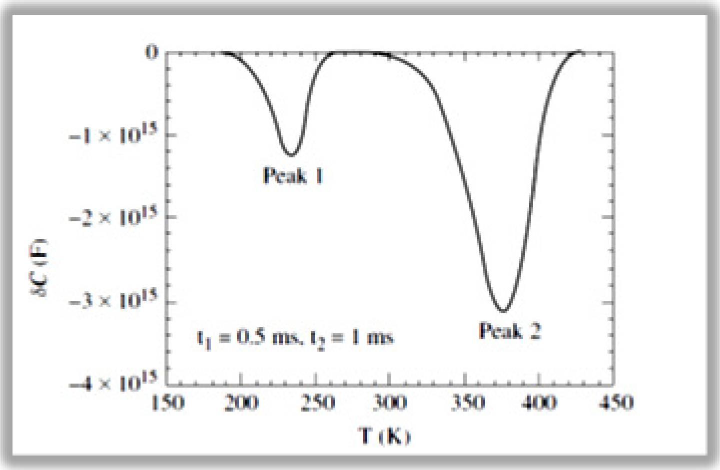
$$ln(\tau_{max} T^2) = -ln(K_n \sigma_n) + \frac{E_C - E_T}{1000k} \frac{1000}{T}$$

6.

$$N_T = \frac{C_{d/peak}}{C(\infty)} \frac{2N_D}{e^{-t_2/\tau_{max}} - e^{-t_1/\tau_{max}}}$$

Exo 02

The deep-level transient spectroscopy (DLTS) curve in Figure 1 was obtained by the boxcar method on a Schottky barrier diode on an *n*-type Si substrate for t_1 = 0.5 ms, t_2 = 1 ms.



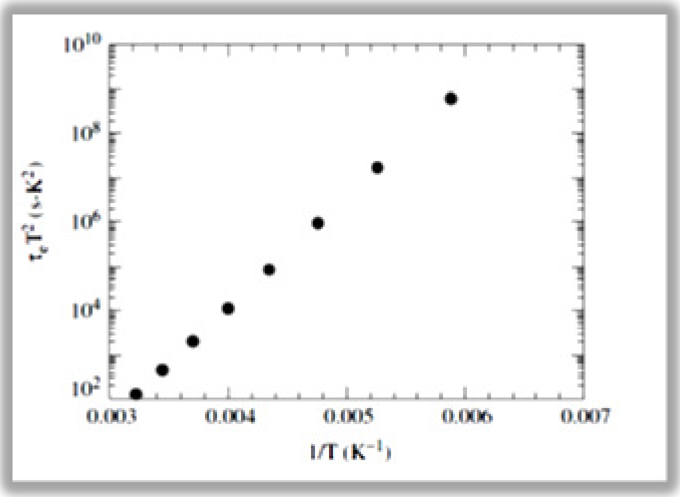
Other curves gave:

t_1 (ms)	t_2 (ms)	$T_{1\max}(K)$	$\delta C_{1\max}$ (F)	$T_{2\max}(K)$	$\delta C_{2\max}$ (F)
0.5	1	234	-1.25×10^{-15}	376	-3.125×10^{-15}
1	2	227	-1.25×10^{-15}	364	-3.125×10^{-15}
2	4	220	-1.25×10^{-15}	352	-3.125×10^{-15}
4	8	213	-1.25×10^{-15}	341	-3.125×10^{-15}
8	16	207	-1.25×10^{-15}	331	-3.125×10^{-15}

Determine $\Delta E = E_C - E_T$, N_T and the intercept σ_n for both peaks. $C_0 = 5 \times 10^{-12} F$, $N_D = 10^{15}$ cm^{-3}, $\gamma_n = 1.07 \times 10^{21}$ cm^{-2}s^{-1}K^{-2}.

Exo 03

The Arrhenius plot of a deep-level impurity in Si is shown in Figure 2. Determine $E_c - E_T$ and σ_n. Use $\gamma_n = 1{,}07 \times 10^{21}$ cm^{-2}s^{-1}K^{-1}, $k_B = 8{,}.617 \times 10^{-5}$ eV/K.



Exo 04

The deep-level transient spectroscopy data in Figure 3 were obtained by the boxcar method on a Schottky barrier diode on a *p*-type Si substrate. The diode area is 0.02 cm^2 and the diode bias voltage was varied from zero to reverse bias voltage of 5V during the measurement. K_s = 11.7, $\gamma_p = 1.78 \times 10^{21}$ cm^{-2}s^{-1}K^{-2}, $N_A = 10^{15}$ cm^{-3}, V_{bi} = 0.87 V. Determine $E_T - E_V$, N_T, and the intercept σ_p for each of the impurities.