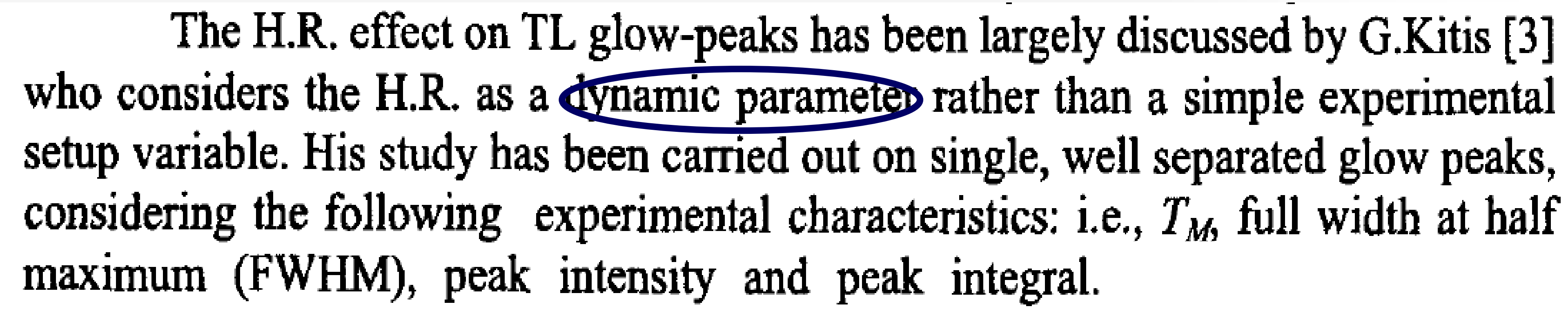
Dependence on the heating rate *β*

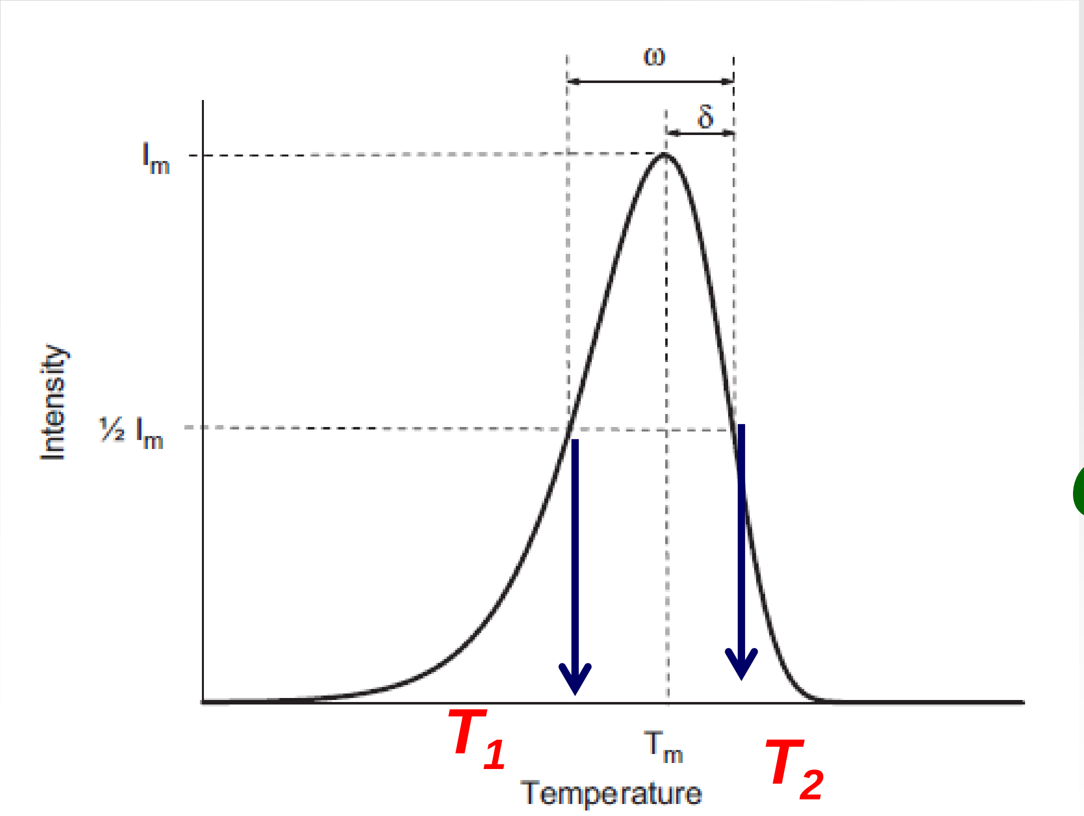
$$I_{TL}(T)=s\cdot\frac{n_0^b}{N}\frac{p_r}{p_t}\cdot\exp\left(-\frac{E}{kT}\right)\cdot\left(1+\underbrace{\frac{p_r}{p_t}\frac{s}{N}\cdot\frac{n_0^{b-1}}{\beta}\cdot(b-1)\cdot\int_{T_0}^{T}\exp\left(-\frac{E}{kT'}\right)dT'}\right)^{\frac{b}{1-b}}$$

Normalisation factor so that the following integral equals to 1, since it represents the probability that all electrons are de-trapped

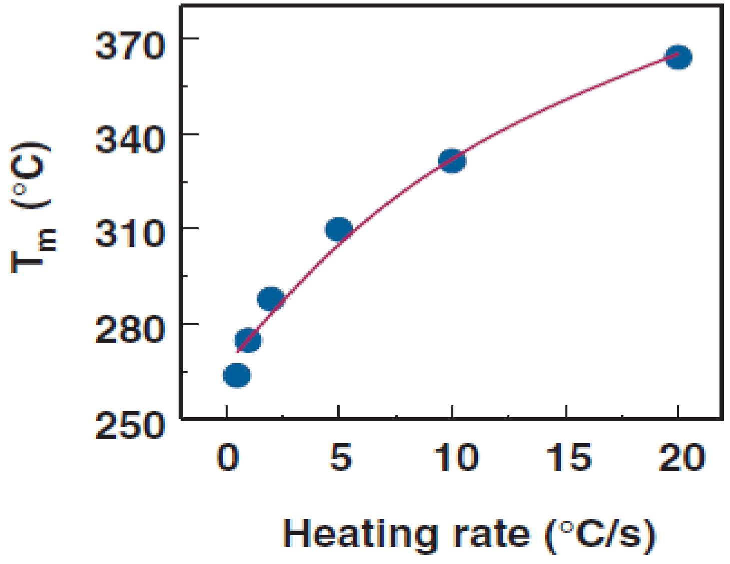


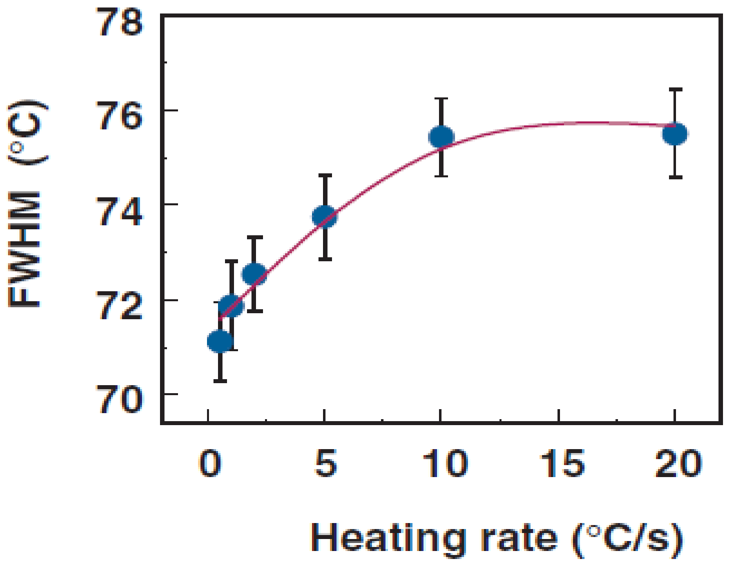
The H.R. effect on TL glow-peaks has been largely discussed by G.Kitis [3] who considers the H.R. as a dynamic parameter rather than a simple experimental setup variable. His study has been carried out on single, well separated glow peaks, considering the following experimental characteristics: i.e., T_M, full width at half maximum (FWHM), peak intensity and peak integral.

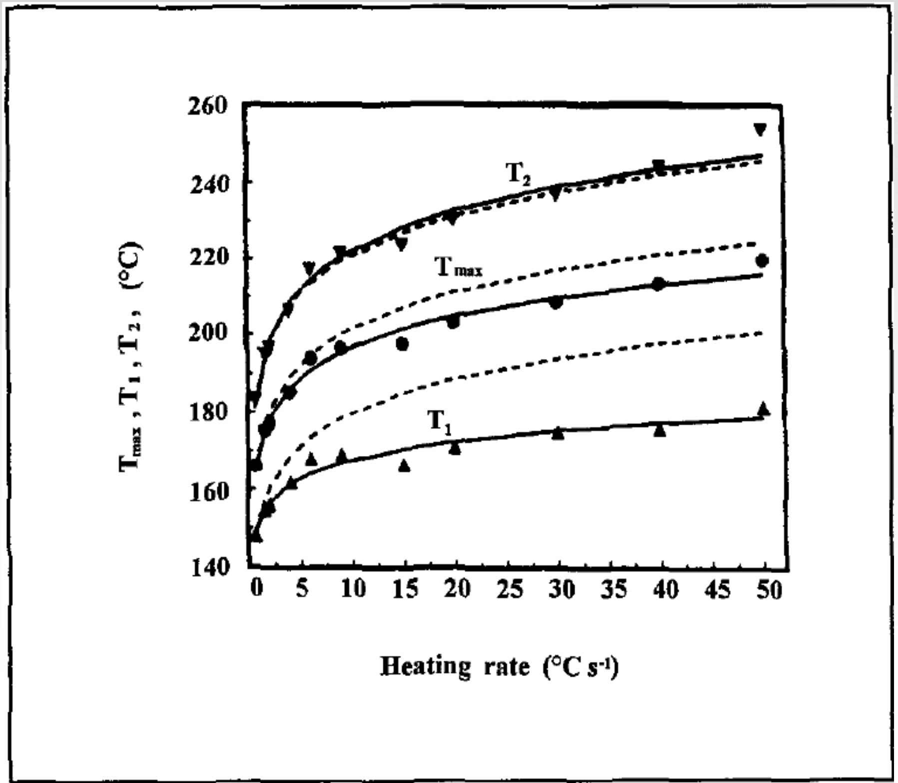
- *The maximum glow-peak temperature Tm is shifted towards higher temperatures as the heating rate increases.*
- *The same takes place for T_1 and T_2. Therefore, the FWHM increases for increasing heating rate.*

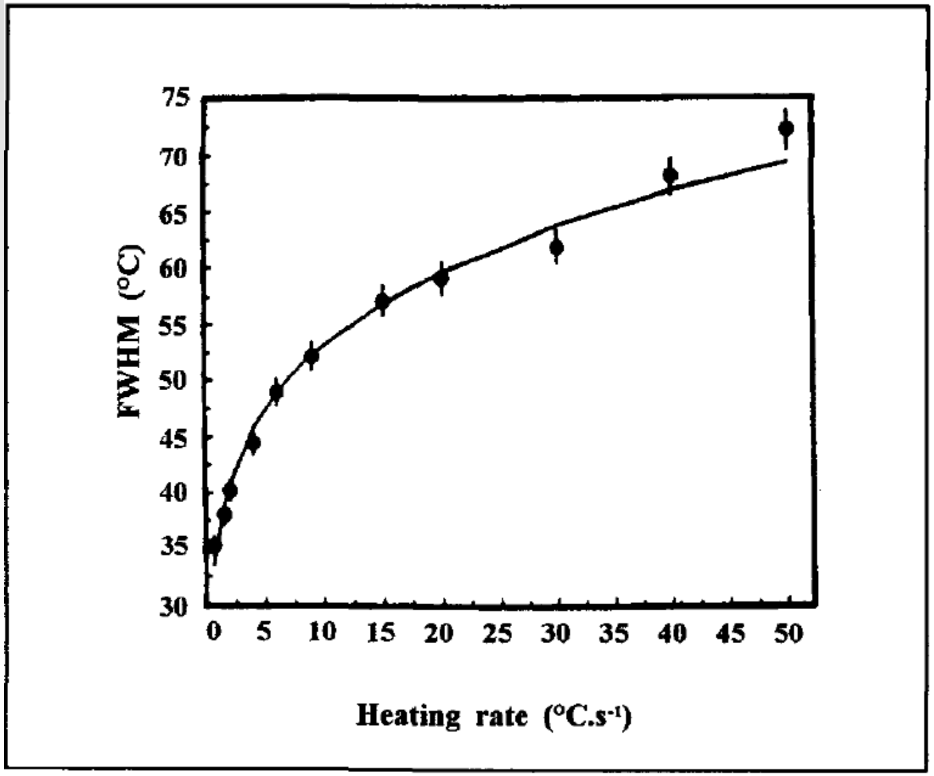


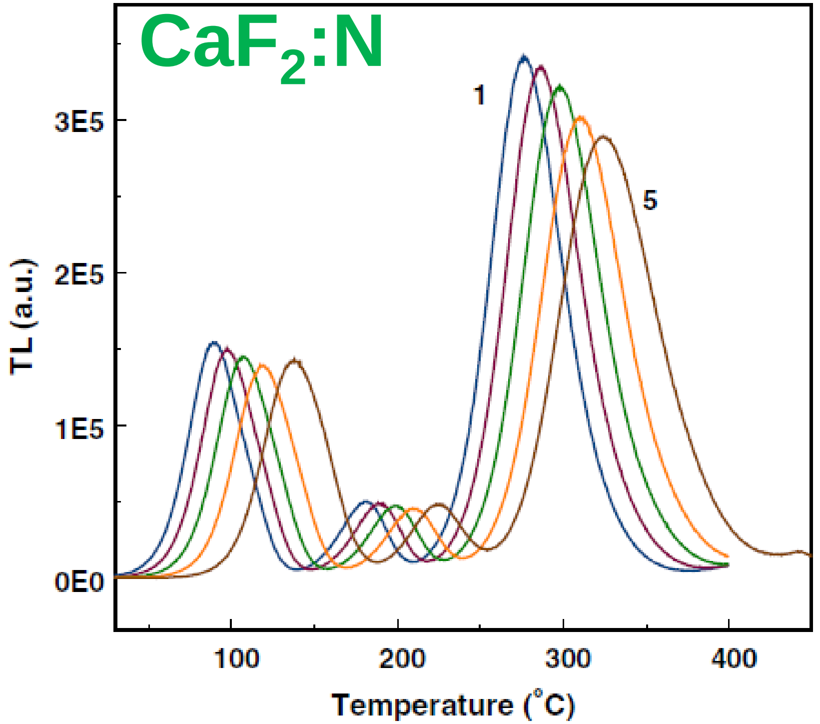
- *The integrated intensity of each single peak stays constant. → Otherwise thermal quenching*


T_m (°C)
370
340
310
280
250
0
5
10
15
20
Heating rate (°C/s)

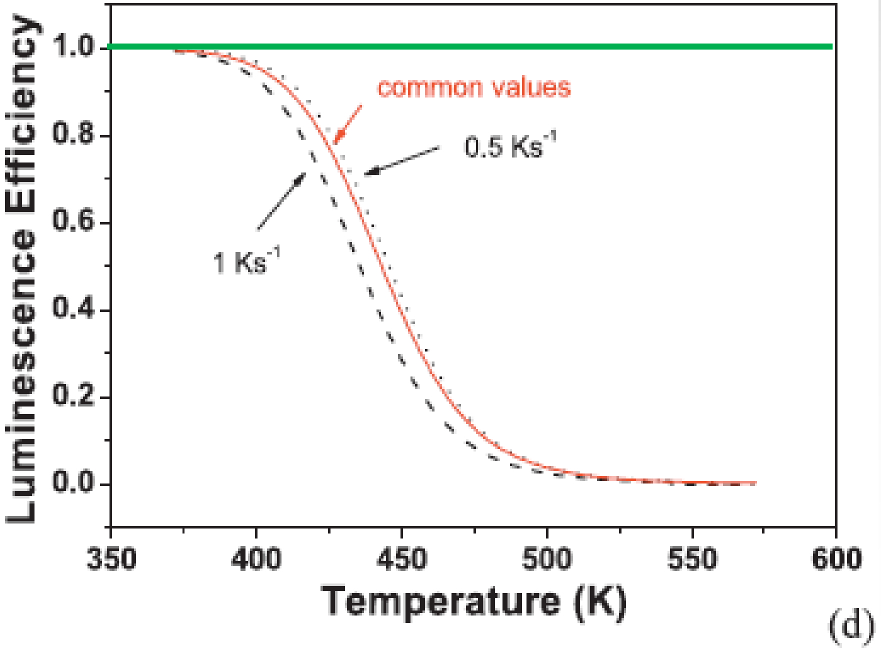

FWHM (°C)
78
76
74
72
70
0
5
10
15
20
Heating rate (°C/s)


T_max , T_1 , T_2 , (°C)
260
240
220
200
180
160
140
T_2
T_max
T_1
0
5
10
15
20
25
30
35
40
45
50
Heating rate (°C s⁻¹)

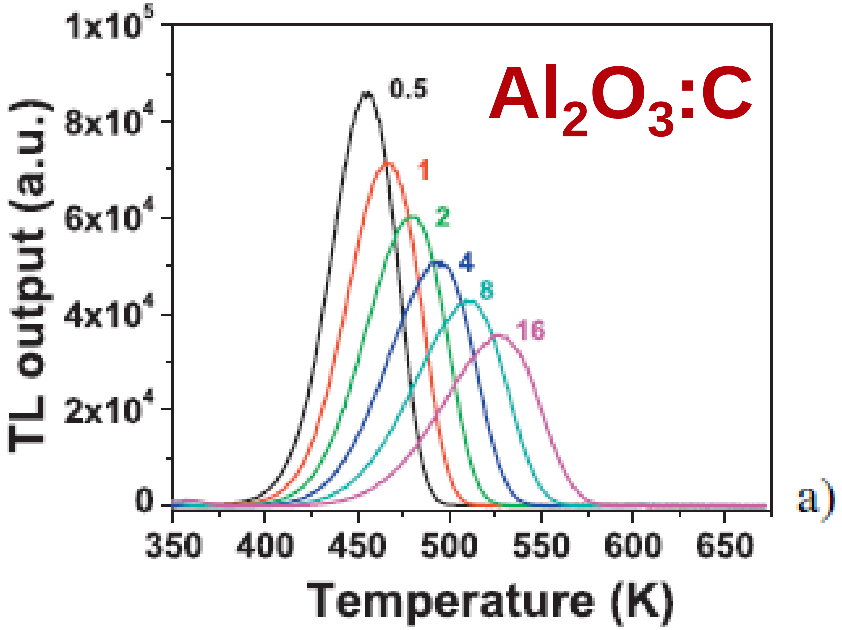

FWHM (°C)
75
70
65
60
55
50
45
40
35
30
0
5
10
15
20
25
30
35
40
45
50
Heating rate (°C.s⁻¹)



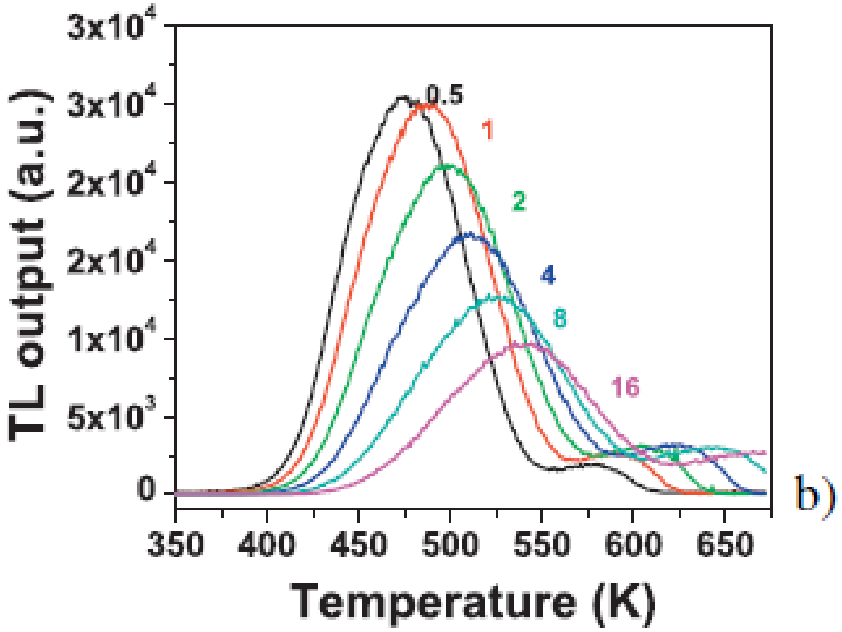
CaF$_2$:N
1
5
TL (a.u.)
3E5
2E5
1E5
0E0
100
200
300
400
Temperature (°C)



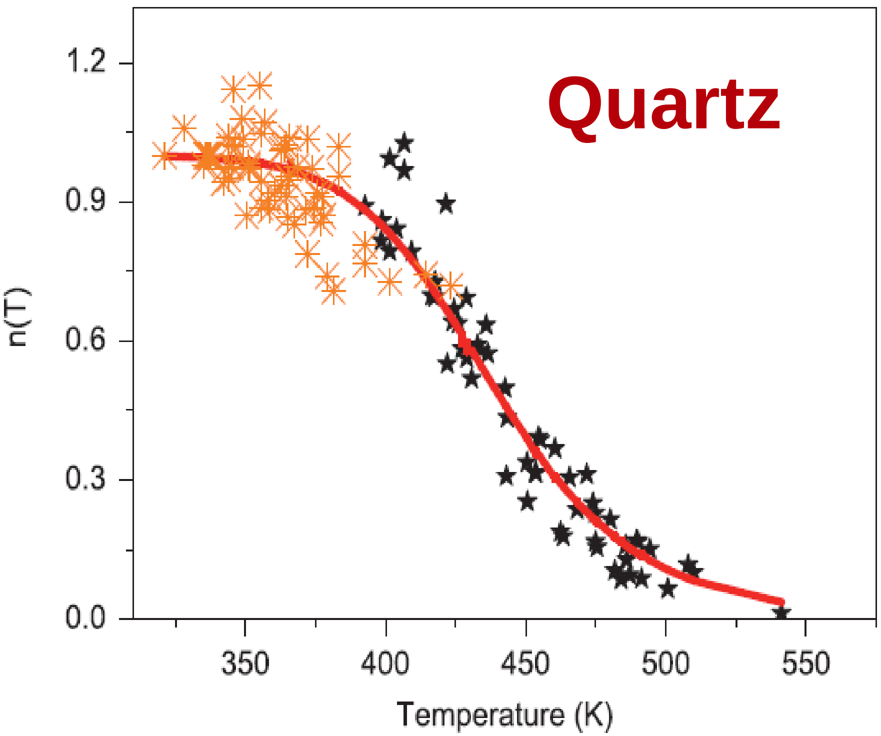
Luminescence Efficiency
1.0
0.8
0.6
0.4
0.2
0.0
common values
0.5 Ks^{-1}
1 Ks^{-1}
350
400
450
500
550
600
Temperature (K)
(d)

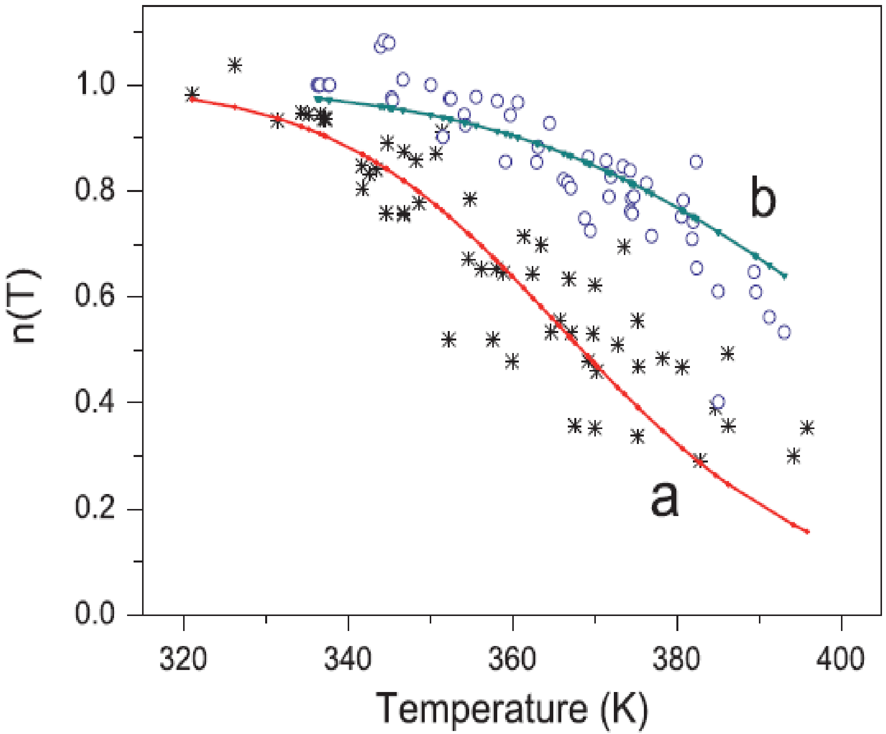


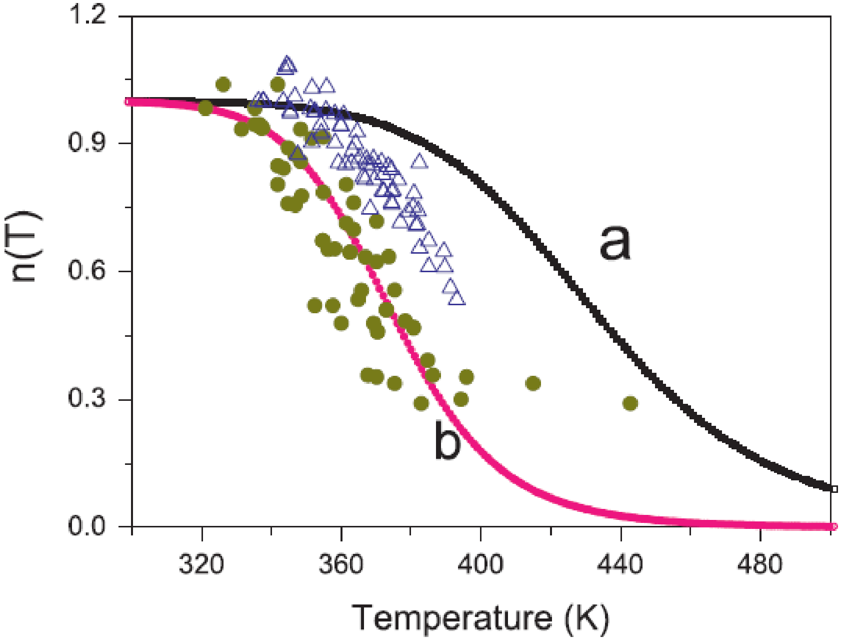
Al$_2$O$_3$:C
TL output (a.u.)
1x10^5
8x10^4
6x10^4
4x10^4
2x10^4
0
0.5
1
2
4
8
16
350
400
450
500
550
600
650
Temperature (K)
a)



TL output (a.u.)
3x10^4
3x10^4
2x10^4
2x10^4
1x10^4
5x10^3
0
0.5
1
2
4
8
16
350
400
450
500
550
600
650
Temperature (K)
b)

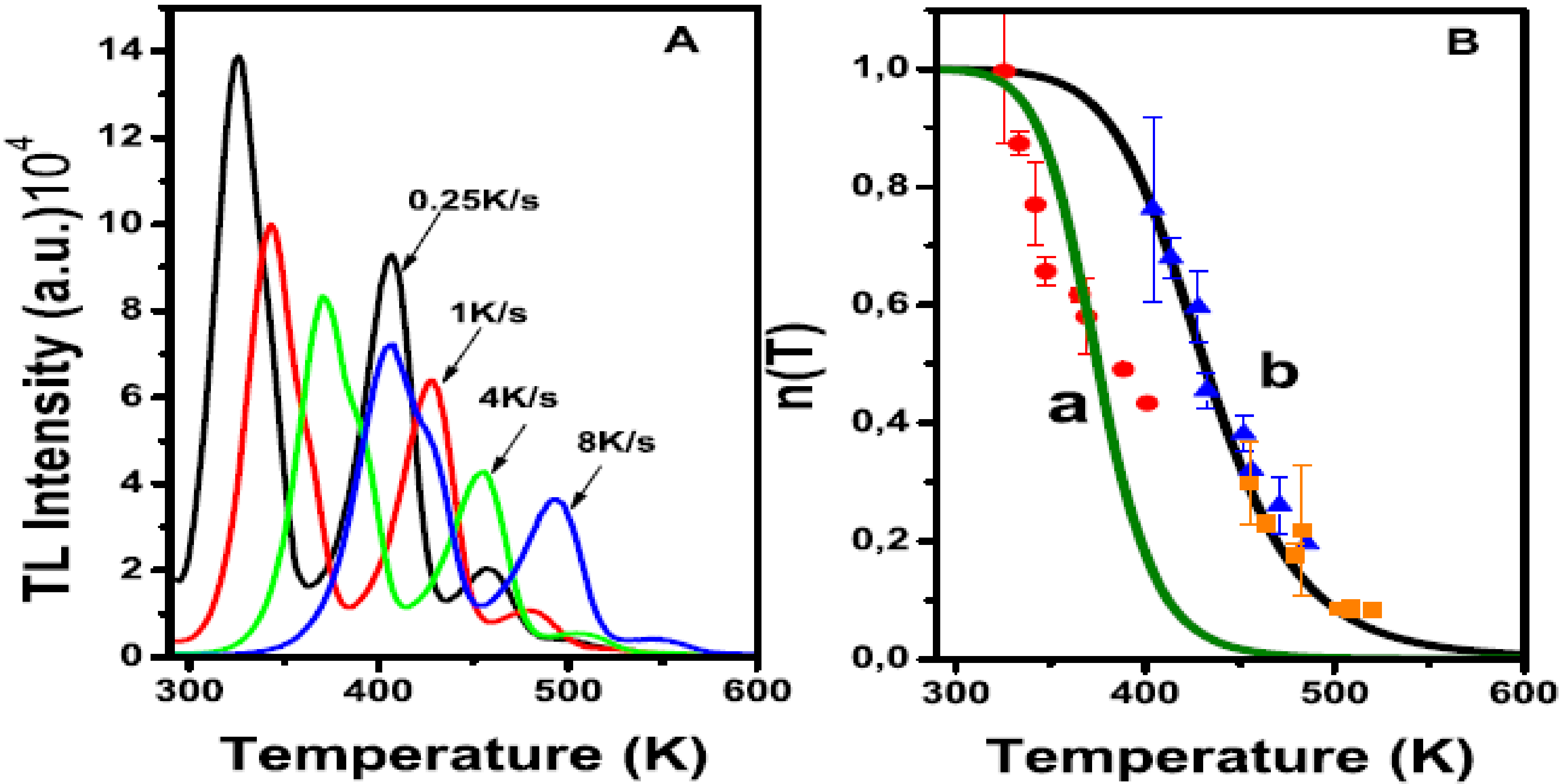






$$\eta = \frac{P_r}{P_r + P_{nr}}$$

$$n = \frac{1}{1 + c\exp(-\frac{\Delta E}{kT})}$$


A
TL Intensity (a.u.)10^4
14
12
10
8
6
4
2
0
0.25K/s
1K/s
4K/s
8K/s
300
400
500
600
Temperature (K)
B
n(T)
1,0
0,8
0,6
0,4
0,2
0,0
a
b
300
400
500
600
Temperature (K)

Quartz

Various heating rates *β method*

$$\frac{\beta_1 E}{kT_{M1}^2} = s\exp(-\frac{E}{kT_{M1}})$$

$$\frac{\beta_2 E}{kT_{M2}^2} = s\exp(-\frac{E}{kT_{M2}})$$

$$E = k\frac{T_{M1}T_{M2}}{T_{M1}-T_{M2}}\ln\left(\frac{\beta_1}{\beta_2}\right)\cdot\left(\frac{T_{M2}}{T_{M1}}\right)^2$$

First order

$$\left(\frac{\beta}{T_M^2}\right) \cong \exp(-\frac{E}{kT_M})\left(\frac{ks}{E}\right)[1+(b-1)\Delta_M]$$

General order