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# Analysis of the life time of quartz TL peaks: Comparison of the deconvolution using the first order kinetic to the Initial Rise Method

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## INTRODUCTION

Quartz is a thermoluminescent material used for thermoluminescence (TL) dating and/or for environmental dosimetry. As good for dating as for dosimetry, one of problems of the use of a thermoluminescent material is the evaluation of the life time of used glow peaks called "used peak". The goal of this present work is in a first time to compare two different programs for deconvolution, and in a second time to compare results of the evaluation of glow peak life time using the method of deconvolution to those using the Initial Rise Method (IRM), these in order to determine the kinetic parameters and hence the glow peaks lifetime. The majority of the present work has been done at the "GSF-Forschungszentrum Umwelt für Gesundheit und -Neuherberg, Munich, Germany" in the frame of a doctoral scholarship by the DAAD "Deutscher Akademischer Austauschdienst" that is the German service of academic exchange.

**Results with GCANEW**

| Peaks positions | $T_m$ (°C) | E (eV) | $\tau$ | FOM (%) |
|---|---|---|---|---|
| Peak1 | 116.2 ± 0.2 | 1.0060 ± 0.0007 | 1.132 ± 0.007 d | |
| Peak2 | 147.2 ± 0.3 | 0.94 ± 0.01 | 5.6 ± 0.9 d | |
| Peak3 | 178.9 ± 0.2 | 1.043 ± 0.004 | 163 ± 9 d | 1.64 ± 0.03 |
| Peak4 | 220.5 ± 0.4 | 0.788 ± 0.005 | 34 ± 3 d | |
| Peak5 | 278.2 ± 0.4 | 1.03 ± 0.01 | 70 ± 20 y | |
| Peak6 | 398.7 ± 0.3 | 1.051 ± 0.004 | 7600 ± 700 y | |

**Results with GCDMAD**

Second order approximation

| Peaks positions | $T_m$ (°C) | E (eV) | $\tau$ | FOM (%) |
|---|---|---|---|---|
| Peak1 | 115.9 ± 0.2 | 1.0056 ± 0.0008 | 1.103 ± 0.009 d | |
| Peak2 | 146.9 ± 0.3 | 0.94 ± 0.01 | 5.6 ± 0.8 d | |
| Peak3 | 178.6 ± 0.2 | 1.044 ± 0.004 | 161 ± 9 d | 1.76 ± 0.03 |
| Peak4 | 219.8 ± 0.4 | 0.789 ± 0.005 | 33 ± 3 d | |
| Peak5 | 277.6 ± 0.4 | 1.03 ± 0.01 | 70 ± 20 y | |
| Peak6 | 397.7 ± 0.3 | 1.051 ± 0.004 | 7300 ± 700 y | |

For the deconvolution, the program developed by J. Mr. Gomez-Ros and A. Delgado (CIEMAT, Spain) called GCANEW and the one that we developed and called GCDMAD are compared.

For the two programs, the first order of kinetics is used but the difference is that the program of the CIEMAT uses the approximation of the second order while ours uses two different approximations for comparison: approximation of the first order and approximation of the second order.

For the GCDMAD, the first order of kinetics has been adopted as physical model and the Marquardt method has been used as smoothing method.

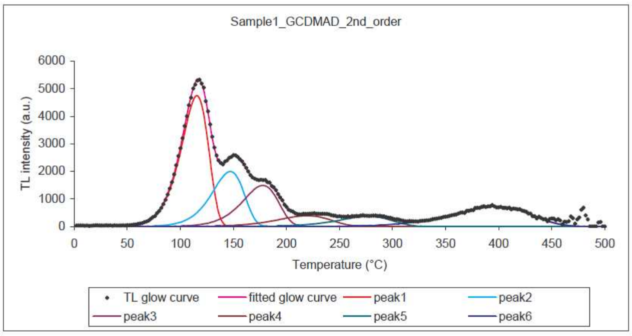


*Figure5.2.a* *An example of deconvolution of TL glow curve by GCDMAD with 2nd ordre approximation.Quartz grains are irradiated by $\beta$ of 10Gy*

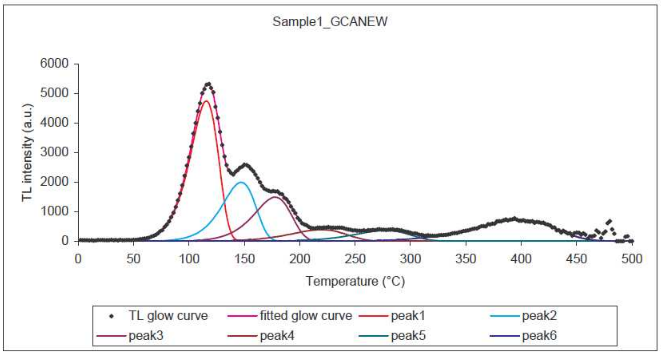


*Figure5.2.b* *. The same TL glow curve as the one of Fig.2.a, but deconvoluted by GCANEW with the approximation of the 2nd order*

| Results | Tm (°C) | E (eV) | τ (years) | FOM (%) |
|---|---|---|---|---|
| With GCDMAD. Second order approximation | 397.7 ± 0.3 | 1.051 ± 0.004 | 7 300 ± 700 | 1.76 ± 0.03 |
| With GCANEW. Second order approximation | 398.7 ± 0.3 | 1.051 ± 0.004 | 7 600 ± 700 | 1.64 ± 0.03 |
| With IRM | 402 ± 1 | 1.44 ± 0.006 | 49 000 000 ± 7 000 000 | 33 |

***Table5.4.*** *Comparison of results from IRM with those from deconvolution on the used peak's life time*

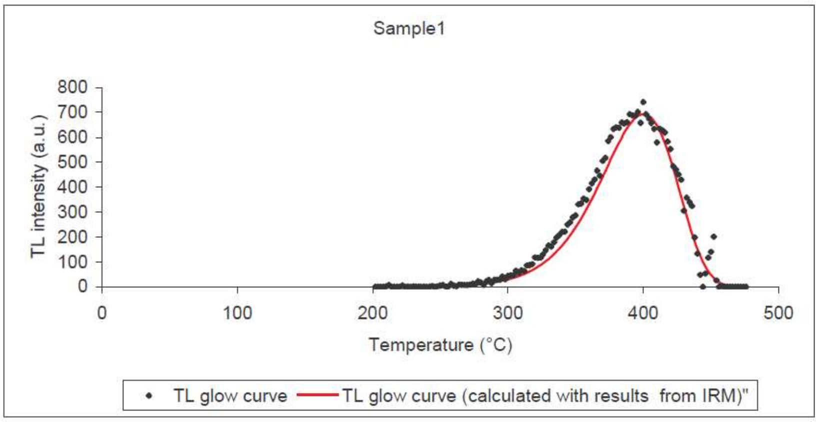


*Figure5.6.* *An example of TL glow peak compared to the fitted curve using values of kinetic Parameters obtained by IRM.*

## Interpretation

FOM result of 33% is highly superior to the acceptable limit for estimating a good smoothing that is 5%. It means that the combination of results from IRM with the equation of the first order kinetic is not compatible with the TL glow curve. One can see this result easily in the Figure5.6. Therefore, one can say that IRM is not compatible with the first order kinetic.

## CONCLUSION

The evaluation of the life time of the "used peak" is very important because this life time should be long enough to estimate the age of an object. The IRM (Initial Rise Method) seems to be promising because the peak life time calculated with this method is long enough (*table5.4*). However, it could be fatal to trust on this method. The preliminary treatment of temperature could not be complete because of peaks juxtaposed in the bottom part of the used peak that is difficult to erase completely. Therefore, in the beginning of the rise of the glow peak, the intensity of thermoluminescence is not really proportional to exp(-E/kT), condition which is nevertheless obligatory to be able to use the IRM.

The deconvolution is the best way to analyze the TL glow curve. Indeed, this method is proven to be precise. With the FOM test that is a method to test the precision, the result shows that the TL glow curve of quartz is really in concordance with the kinetic model of the first order, with either first or second order approximation. However, it could be an enormous mistake if one considers results from the deconvolution and without correction considering the bleaching test, which will be our perspective works.