The computerized glow curve deconvolution (CGCD) has led to important advance in thermoluminescence (TL) dosimetry. Unfortunately, using this method with high precision in the routine work or even in the dosimetric studies is still having some theoretical, mathematical and computational problems besides the experimental ones. These problems restrict and limit the usage of the CGCD method, especially using the complicated models, in the TL studies. Therefore, this study attempts to discuss and provides reliable solutions for these problems and illuminate the importance of the CGCD’s usage in the TL dosimetry. The TL theoretical models and the trap parameters evaluation methods are theoretically represented and discussed. The mathematical and computational problems and their solutions are also represented and discussed. The applications of using the CGCD in dosimetric studies are discussed.

A new software, glow curve analysis fit (GCAFit) was designed to theoretically analyze the TL glow curves and to evaluate the trapping parameters. The technical computing language, MATLAB, was used to design the computational models. The first designed computational model was based on the first-order kinetics model. Unlike other models, the designed computational model does not need the activation energy, E, as input datum; on the contrary, the activation energy for each glow peak is given as the output data. The first-order equations are characterized by the fast convergence process and which lead to less computational time. This computational process was then used as an initial step in designing a computational model based on the general-order kinetics (GOK) equation. Mainly, there are two problems in using the GOK equation. The first one is related to the difficulties in the optimization process, while the second one is related to an integral part which has no analytical solution. The first problem was solved by employing the general peak shape method to evaluate the initial values of the kinetics parameters in the GOK equation. The second one was solved using the approximation solution provided by Krich giving a more accurate solution than other.

The GCAFit method using the first-order kinetics model equation was applied on the glow curves of 8 ribbons of each type of LiF:Mg,Ti (TLD-100, 600 and 700) dosimeters irradiated with a Co-60 gamma source. The values of activation energy obtained for each peak by the deconvolution process were compared with those obtained by the peak shape methods of Grossweiner, Lushchik and Halperin-Braner. The frequency factor, S, was also calculated for each peak. The standard deviation values of the kinetics parameters obtained by the GCAFit software for each glow peak were discussed and compared with other investigator. The results show that the standard deviation of E increases with the decrease of the resolution of the observed experimental glow curve, the glow peak consists of more than one peak, or the glow peak deviate from the pure first-order peak.

The results also show that the values of E obtained by the deconvolution process are in agreement with those obtained by the peak shape methods. The agreement with both the Lushchik and Halperin-Braner methods was better than that of Grossweiner. High E and S values were observed for the main dosimetric glow peak 5. The glow curves of LiF:Mg,Ti (TLD-100, 600 and 700) in the case of gamma rays irradiation were analyzed by two manners using the first-order kinetics model. The first analysis process started from the lowest temperature upwards (ascending manner), while the second one started from highest temperatures (descending manner).
temperature downwards (descending part). A comparison between the two manners was performed. The results showed that in the case of the second manner, a significant improvement in the precision of the obtained kinetics parameters and the deconvolution quality was observed.

The GCAFit method using the GOK equation was applied to determine the order of kinetics (b) for each glow peak. It was shown that most of the glow peaks, including peak 5, did not deviate from the first-order glow peak shape except the high temperature glow peaks. Thus, it is believed that the high E and S values for peak 5 are not real values. These values were considered as effective values $E_{\text{eff}}$ and $S_{\text{eff}}$. Also, the peak position was treated as effective position $T_{m(\text{eff})}$. The expected real values were discussed and the real glow peak 5 was simulated using another theoretical model based on the assumption that the glow peak 5 is related to a trimer Mg$_2$+V energy level.

A comparison between the first-order and the general-order kinetics models in analyzing the glow curves of LiF:Mg,Ti (TLD-100, 600 and 700) in the case of gamma rays irradiation was performed. It has shown that the percentage differences between the activation energy obtained by the two models are negligible for peaks 3, 4 and 5, while significant differences were observed for the high temperature glow peaks 7 and 8. The precision of the GOK equation in obtaining the kinetics parameters was better than that of the first-order kinetics equations for all the glow peaks. However, the precision of the first-order equation is accepted for the applicable cases.

The GCAFit software was employed to study the dose response of the TL glow peaks of 8 pairs of TLD-600 and TLD-700 which were irradiated with 0.77, 1.92, 3.85, 7.70, 19.2, 37.5, and 145.7 mGy from Co-60 with a constant dose rate of 2.24 mGy/h (diagnostic level). The results showed that the background noise signals influenced on the dose response of the total area under the glow curve and of the (2-5) glow peaks integral part. The glow peaks 2 and 8 did not show any dose linearity in this dose range. However, an improvement in the dose response curve was observed on applying the GCAFit method.

Also, the eight pairs of the TLDs were irradiated with 0.58, 1.08, 5.54, 10.15, 20.55 Gy with a higher dose rate of 7.5 Gy/h (therapy level). A deviation from the linearity of peak 5 was observed at absorbed dose level $>\sim 10$ Gy using the GCAFit when compared to that observed at $\sim 5$ Gy for the unanalyzed glow curves. However, the glow peaks 2, 3 and 7 showed an extension of the linearity up to $\sim 20$ Gy.

Eight pairs of TLD-600 and TLD-700 dosimeters were used in an attempt to discriminate between the different radiation particles in neutron mixed field. The GCAFit was applied on the glow curves of the dosimeters irradiated with 241Am-Be neutron source. The dose response of each glow peak was explained. The results showed that only the glow peaks 3, 4 and 5 exhibited a linear behavior with the absorbed dose. The thermal neutron induced dose $D_{n(\text{th})}$ was calculated for each glow peak. The results were unexpected, since each glow peak has shown different sensitivity to the thermal neutron induced dose. The glow peak 3 showed the highest sensitivity, even higher than that of the main glow peak 5. A negative value of the $D_{n(\text{th})}$ was observed for the glow peak 7 which is could be attributed to the sensitivity of this glow peak 7 to fast neutrons. This methodology of using pairs of TLD-600
and TLD-700 dosimeters contains many assumptions that may affect its accuracy. Therefore, it requires future studies to provide more reliable and accurate results in dosimetry of mixed fields.