Towards multi-exponential analysis in optically stimulated luminescence

Optically stimulated luminescence (OSL) data from quartz can follow different mathematical forms depending on the stimulation mode. These data can be described in terms of different multi-exponential models and can be numerically fitted using several well-known methods. Here we make a comparative analysis of the performance and stability of two models, the decay and peak form, and we consider different transformation methods for obtaining the peak form. For the numerical computations we use a nonlinear least squares (NLS) method and a method based on a first-kind Fredholm integral equation (FIE). Our analysis uses artificial data with three components (seven parameters including the background) and ten different levels of background, both the signal and the background contain Poisson distributed noise. Parameters derived using both models are acceptable (statistically consistent and on an average within similar to 1% of the expected value) and no obvious preference is observed for any particular model, although there may be a suggestion that peak-form data show a smaller mean bias. This conclusion seems to be independent of the type of peak transformations investigated here. Furthermore, it is found that transformation of OSL decay data to a peak form gives better results than direct measurement of peak-form data by, for example, varying the stimulation light intensity. The comparison of the two numerical methods suggests that the NLS method performs somewhat better than the FIE method; however, the latter has the advantage that it does not require the user's judgement on the number of components in the data. Testing of the NLS procedure on a measured quartz time-resolved OSL signal transformed into peak form yielded reliable parameter estimates even when the signal intensity was deliberately reduced by a factor of 16.