

Deconvolution of isothermal TA – OSL decay curves from sedimentary quartz using combinations of various contemporary models

The image shows the front cover of the journal 'Radiation Measurements'. At the top left is the Elsevier logo, which includes a tree and the text 'ELSEVIER' and 'NON SOLUS'. To the right of the logo, the text 'JOURNAL OF THE INTERNATIONAL UNION OF PURE AND APPLIED PHYSICS' is printed in a small, sans-serif font. The title 'Radiation Measurements' is prominently displayed in a large, bold, serif font. Below the title, the 'Editorial Board' is listed, including 'Prof. J. D. van Turnhout, University of Technology, The Netherlands' and 'Dr. A. M. J. van der Veen, University of Technology, The Netherlands'. A large, stylized graphic of an atomic nucleus with three protons and two neutrons is positioned on the left side of the cover. The right side of the cover is a solid dark blue color. On this blue background, the text 'JOURNAL COVERAGE' is followed by a list of topics: 'Nuclear Tracks', 'Instrumentation', 'Optically Stimulated Luminescence', 'Thermoluminescence', 'Space Radiation Effects and Measurements', 'Radiation Effects', 'Dating', 'Radiation, Ionizing Particles', 'Track Physics', and 'Basic Physical Processes'.

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Deconvolution of isothermal TA – OSL decay curves from sedimentary quartz using combinations of various contemporary models

George S. Polymeris^{a,*}, Eren Şahiner^a, Engin Aşlar^a, George Kitis^b, Niyazi Meriç^a

^a *Institute of Nuclear Sciences, Ankara University, 06100 Beşevler, Ankara, Turkey*

^b *Nuclear Physics Laboratory, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece,*

Abstract

Thermally assisted optically stimulated luminescence (TA – OSL) stands as an experimental technique which encompasses the simultaneous use of optical and thermal stimulation. The technique can effectively stimulate electrons from traps with delocalization temperatures beyond 500 °C, also known as very deep traps (VDTs). For the case of quartz, TA – OSL is usually measured isothermally, at constant elevated temperature, yielding a decaying shape similar to that reported for the cases of conventional OSL. This feature is prevalent for all quartz samples. In the framework of the present study, a deconvolution analysis was attempted on the corresponding isothermal TA – OSL decay curves of 5 different quartz samples collected from the Aegean Anatolia region, Turkey. Deconvolution was performed on isothermal TA – OSL signals measured at a wide range of stimulation temperatures. Combinations of three different, well established, contemporary luminescence models were applied, two involving delocalized recombination via the conduction band, namely general order kinetics and photo-transfer models, along with one involving both tunneling recombination and delocalized recombination pathways. The use of ~~solely~~ the model of general order of kinetics alone gives physically meaningless results, as the photo-ionization cross section of a specific component indicates a behavior which contradicts the luminescence models, yielding inverse Arrhenius law behavior. A combination of the general order kinetics and the photo-transfer models yields results without major physical inconsistencies. However, the thermal quenching parameters obtained according to the deconvolution procedure do not agree with the corresponding prevalent or representative values for quartz. This latter feature, in conjunction to (a) the shapes of the residual thermoluminescence signal after TA – OSL, (b) the shapes of the TA – OSL with linear heating and (c) the shapes of the isothermal TA – OSL curves normalized over the initial intensity, suggest that the major part of the TA – OSL signal recombines via tunneling. The use of a combination of tunneling plus general order kinetic models has also been applied for the deconvolution analysis. The physically

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