

Upper limits of laser pulse widths required for melanosome and epidermal specific damage

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Abstract

A critical analysis of thermal relaxation times used as an upper limit of laser pulse widths after the absorption of laser radiation by pigmented epidermal lesions has been made. Only the case in which the radiation is absorbed mainly by melanin-containing melanosomes within the tissue is treated. Two of the known criteria currently used to estimate relaxation times are compared, and relaxation times based on an exact solution of the heat conduction equation are found. Numerical results indicate that the relaxation times needed for the temperature to reach its maximum value at a given distance from the melanosome are in the range 0–5.0 μs when the distance varies in the range 0.5–2.0 μm for a typical melanosome radius of 0.5 μm , and for laser pulse widths much shorter than the corresponding non-zero relaxation times. It is shown that, with visible and ultraviolet laser pulses, it is difficult selectively to damage epidermal lesions that have a low density of melanosomes. It is suggested, therefore, that these lesions can be treated with low-fluence infrared radiation from, for example, a CO₂ laser. This suggestion agrees with experimental results published by other authors.

Keywords Laser damage, Thermal modelling, Biological tissue, Relaxation time, Epidermal lesion