

# Polarization-based characterization of laser thermal treatment on biological tissue

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**Abstract:** The field of biomedical optics is promising in medical praxis. The study of laser thermal treatment and polarization-based characterization of tissue under it can be utilized in the correction of certain disorders with good results.

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## 1. Introduction

Biomedical applications of optical techniques are a promising tool in order to help in medical praxis. Optical treatment of disorders can be very effective in some cases, and also optical characterization of tissue allows hidden information to be seen and consequently used in diagnosis or in guided treatment.

Laser-tissue interactions can be divided thoroughly in thermal and photoablative [1]. The latter is usual in surgery, and here interest is on thermal interaction, used in low thermal therapy and in photodynamic therapy [2].

In this work, thermal treatment of biological tissue is studied, and a polarization-based characterization is realized in order to control the process. Thermal treatment is modeled by means of a combined Radiation Transport Theory (RTT), solved by a Monte Carlo numerical method [3], and a bio-heat equation, solved via a finite difference method. Attention is paid to thermal damage, and a polarization analysis allows the monitorization of the process.

## 2. Optical treatment

As it was stated before, laser thermal treatment is studied. Light propagation is modeled with a RTT equation, solved by means of a Monte Carlo numerical method. Data of light absorption obtained can be further used in a bio-heat equation (equation 1) that describes how thermal energy is distributed inside the tissue, taking into account conduction, radiation, convection and even vaporization effects.

$$\int_V q(\vec{r}, t) dV = \int_V \rho c \frac{dT(\vec{r}, t)}{dt} dV - \int_S k \nabla T(\vec{r}, t) \cdot \hat{n} dS - \int_V \rho_b c_b w_b [T_{art}(\vec{r}, t) - T_{ven}(\vec{r}, t)] dV \quad (1)$$

This equation is numerically solved with a finite difference method, and further calculations are made about thermal damage by an Arrhenius analysis. Experimental data of temperature distributions are presented.

## 3. Optical characterization

Laser thermal treatment can be monitorized by optical polarization techniques in order to assure the efficiency of the result. Polarization of light is a contrast parameter that increases the information obtained. A complete polarization characterization of tissue, including depolarization data, requires the measurement of Mueller matrix with a polarimeter. Tissue structures are intimately related with polarization effects, and therefore polarization-based characterization of biological tissue under laser thermal treatment becomes adequate. Numerical treatment of Mueller matrix coefficients increases the amount of information available. Potential applications of laser thermal treatment in multiple disorders are promising [4].

## 4. References

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