Optodynamic Analysis of Laser Induced Thermal Effects at Air-Water Interfaces

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The growing use of lasers in medicine, chemical analysis, industrial process monitoring, and other areas increasingly demands knowledge about the light to thermal energy conversion. A particular topic that, to our knowledge, has not yet been adequately addressed is energy conversion and the accompanying phenomena at a liquid surface. The processes involved depend strongly upon the incoming light intensity and temporal profile. In this contribution, the absorption of a focused pulsed laser beam in the vicinity of an air-water interface and the subsequent thermal processes are investigated experimentally. The complex thermal and mechanical phenomena following the absorption of light are treated in the area of optodynamics. Opto-thermal conversion leads to a generation of optodynamic waves, which propagate into the surrounding medium, carrying information about the source, such as the size and spatial distribution. The characteristics of the optodynamic source yield information about the underlying generation mechanisms.

An IR pulsed laser beam was focused in the vicinity of the distilled water surface. The focus was moved, in steps in the vertical direction, from its original position in the air, slightly above the surface, downwards, to the interface and inside the water. The generated optodynamic waves were detected by probe beam deflection. Two probe beams were used simultaneously, both laying parallel to the surface, one inside the water and the other in the air. The analysis and comparison of the waveforms captured in the two media provide information about the position and size of the optodynamic source relative to the interface, indicating the relative efficiency of thermal energy conversion that takes place in the vicinity of the interface, in both the air and the water. Three distinct optodynamic source positions are identified: in the air, at the interface, and inside the water.