Electrochemical measurement of near-wall flows induced by laser cavitation bubbles

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Micro flows by a collapsing bubble close to a solid boundary are monitored by an electrochemical method. For this purpose, a microelectrode implanted into the boundary is employed. Simultaneous high-speed video recordings are used to correlate bubble dynamics and electrochemical current signal. The bubble is produced by a focused intense light pulse from a Nd:YAG laser. It reaches a maximum diameter of the order of 1 mm and collapses after about 100 μs. The controlled position and timing of the bubble collapse allows for a precise spatio-temporal scan of the near-boundary flow in terms of electrode current. The observed flow patterns can be distinguished into different parts, acting at earlier and later instants of time after collapse. Results are important for cavitation erosion and cleaning applications of ultrasound.

The figure contains images from high speed recordings (exposure time 350 ns to 1 μs) and illustrates the behavior of the collapsing bubble close to a solid wall. Simultaneously to the high speed videos, an electrical current through the electrode is measured employing chronoamperometry. With this method the flow in a very small volume (order of (20 μm)³) and only in direct vicinity to the boundary can be resolved with a short sample interval of 3.3 μs (see upper curve in the figure). Different stages of bubble induced flows and their effect at the wall can be identified and their potential with respect to cleaning and erosion will be discussed.