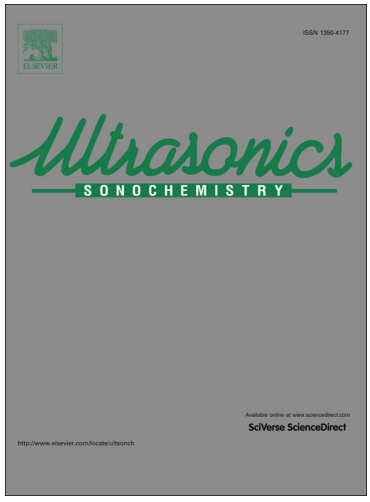

High-speed imaging of ultrasound driven cavitation bubbles in blind and through holes

Markus Kauer, Valentina Belova-Magri, Carlos Cairós, Gerd Linka, Robert Mettin

PII: S1350-4177(18)30641-2
DOI: https://doi.org/10.1016/j.ultsonch.2018.04.015
Reference: ULTSON 4152

To appear in: *Ultrasonics Sonochemistry*

Received Date: 1 March 2017
Revised Date: 23 April 2018
Accepted Date: 25 April 2018

Please cite this article as: M. Kauer, V. Belova-Magri, C. Cairós, G. Linka, R. Mettin, High-speed imaging of ultrasound driven cavitation bubbles in blind and through holes, *Ultrasonics Sonochemistry* (2018), doi: https://doi.org/10.1016/j.ultsonch.2018.04.015

High-speed imaging of ultrasound driven cavitation bubbles in blind and through holes

Markus Kauer[1,2], Valentina Belova-Magri[1], Carlos Cairós[2], Gerd Linka[1], Robert Mettin[2,*]

[1]*Atotech Deutschland GmbH, Erasmusstraße 20, 10553 Berlin, Germany*
[2]*Drittes Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany*

Abstract

The interest in application of ultrasonic cavitation for cleaning and surface treatment processes has increased greatly in the last decades. However, not much is known about the behavior of cavitation bubbles inside the microstructural features of the solid substrates. Here we report on an experimental study on dynamics of acoustically driven (38.5 kHz) cavitation bubbles inside the blind and through holes of PMMA plates by using high-speed imaging. Various diameters of blind (150, 200, 250 and 1000 µm) and through holes (200 and 1000 µm) were investigated. Gas bubbles are usually trapped in the holes during substrate immersion in the liquid thus preventing their complete wetting. We demonstrate that trapped gas can be successfully removed from the holes under ultrasound agitation. Besides the primary Bjerknes force and acoustic streaming, the shape oscillations of the trapped gas bubble seem to be a driving force for bubble removal out of the holes. We further discussed the bubble dynamics inside microholes for water and Cu^{2+} salt solution. It is found that the hole diameter and partly the type of liquid media influences the number, size and dynamics of the cavitation bubbles. The experiments also showed that a large amount of the liquid volume inside the holes can be displaced within one acoustic cycle by the expansion of the cavitation bubbles. This confirmed that ultrasound is a very effective tool to intensify liquid exchange processes, and it might significantly improve micro mixing in small structures. The investigation of the effect of ultrasound power on the bubble density distribution revealed the possibility to control the cavitation bubble distribution inside the microholes. At a high ultrasound power (31.5 W) we observed the highest bubble density at the hole entrances,