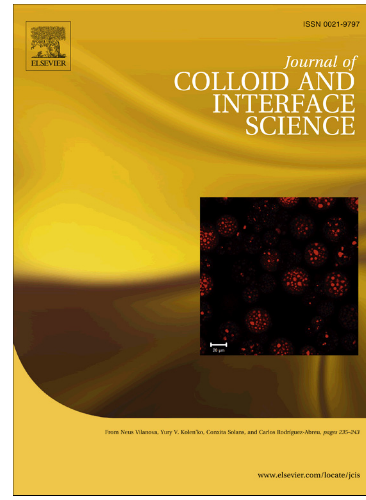
Accepted Manuscript



Pulsed laser ablation in liquids: Impact of the bubble dynamics on particle formation

Stefan Reich, Patrick Schönfeld, Philipp Wagener, Alexander Letzel, Shyjumon Ibrahimkutty, Bilal Gökce, Stephan Barcikowski, Andreas Menzel, Tomy dos Santos Rolo, Anton Plech

PII: S0021-9797(16)30585-9
DOI: http://dx.doi.org/10.1016/j.jcis.2016.08.030
Reference: YJCIS 21498

To appear in: *Journal of Colloid and Interface Science*

Received Date: 28 June 2016
Revised Date: 10 August 2016
Accepted Date: 11 August 2016

Please cite this article as: S. Reich, P. Schönfeld, P. Wagener, A. Letzel, S. Ibrahimkutty, B. Gökce, S. Barcikowski, A. Menzel, T. dos Santos Rolo, A. Plech, Pulsed laser ablation in liquids: Impact of the bubble dynamics on particle formation, *Journal of Colloid and Interface Science* (2016), doi: http://dx.doi.org/10.1016/j.jcis.2016.08.030

Pulsed laser ablation in liquids: Impact of the bubble dynamics on particle formation

Stefan Reich[a], Patrick Schönfeld[a], Philipp Wagener[b], Alexander Letzel[b], Shyjumon Ibrahimkutty[c], Bilal Gökce[b], Stephan Barcikowski[b], Andreas Menzel[d], Tomy dos Santos Rolo[a], Anton Plech[a],

[a]*Institute for Photon Science and Synchrotron Radiation, Karlsruhe Institute of Technology, PO 3640, D-76021 Karlsruhe*
[b]*University of Duisburg-Essen, Technical Chemistry I and Center of Nanointegration Duisburg-Essen (CENIDE), Universitaetsstrasse 7, D-45141 Essen*
[c]*MPI for Solid State Research, Heisenbergstr. 1, D-70569 Stuttgart*
[d]*Paul-Scherrer Institute, CH-5232 Villigen PSI, Switzerland*

Abstract

Pulsed laser ablation in liquids (PLAL) is a multiscale process, involving multiple mutually interacting phenomena. In order to synthesize nanoparticles with well-defined properties it is important to understand the dynamics of the underlying structure evolution. We use visible-light stroboscopic imaging and X-ray radiography to investigate the dynamics occurring during PLAL of silver and gold on a macroscopic scale, while X-ray small angle scattering is utilized to deepen the understanding on particle genesis. By comparing our results with earlier reports we can elucidate the role of the cavitation bubble. We find that symmetry breaking at the liquid-solid interface is a critical factor for bubble motion and that the bubble motion acts on the particle distribution as confinement and retraction force to create secondary agglomerates.

Keywords: Pulsed laser ablation in liquids, time-resolved small angle scattering, fast X-ray radiography, stroboscopy, hydrodynamics

1. Introduction

The understanding of pulsed-laser ablation in liquids for the synthesis of nanoparticles has strongly improved within the last years (1; 2). As a synthesis method for a wide range of material classes (3; 4; 5) the control of central parameters, such as nanoparticle yield (6), accessible size distribution and chemical interaction or speciation is of high importance for prospective applications. Being a multiscale process in space and time it is particularly difficult to resolve a functional relationship between the different phenomena, such as laser-matter interaction, plasma formation, liquid boiling and bubble formation, nanoparticle genesis, as well as growth and stabilization effects.

Recently, theoretical advances (7; 8; 9; 10; 11) in the description of the target behaviour during phase explosion after light absorption both in continuum calculations and molecular dynamics simulations have

Email address: anton.plech@kit.edu (Anton Plech)