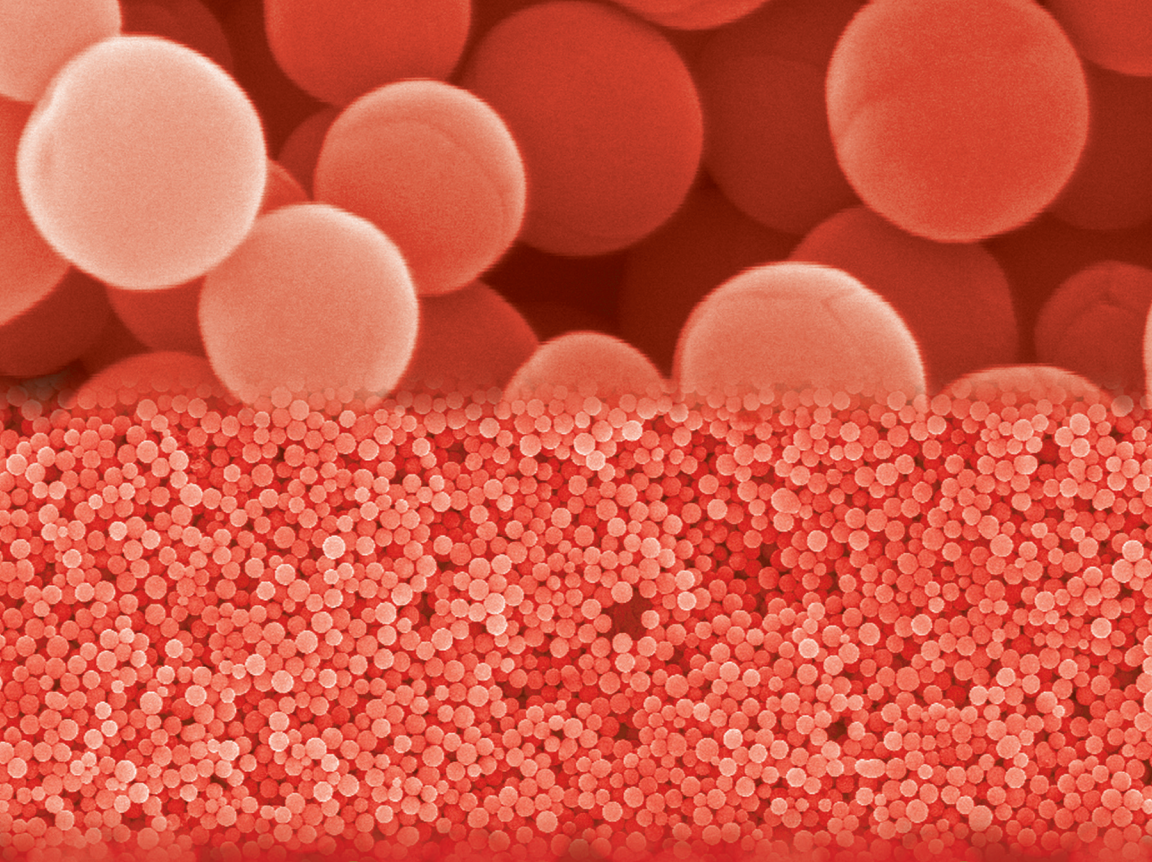

LASER ABLATION IN LIQUIDS

Principles and Applications in the Preparation of Nanomaterials

edited by
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Contents

Preface

Laser Ablation in Liquids: Principles and Applications in the Preparation of Nanomaterials is the first comprehensive reference to consider both fundamental and applied aspects of laser ablation of a solid target in liquid-in-liquid environments. As we know, laser ablation of solid materials has been studied intensively for a long time since laser technology was developed, because it has shown immense potential in laser-based material processing, including thin solid film preparation, material cutting, drilling, alloying, welding, and so on. Since laser ablation of solid materials is easily carried out in conventional deposition chambers with vacuum or filled gas, most researchers have focused their attention on laser ablation of a solid target in vacuum and diluted gas while aiming at various applications just mentioned.

Pulsed-laser ablation takes place at the gas–solid interface. Compared with applications of pulsed-laser ablation in vacuum or diluted gas, applications of pulsed-laser ablation of a solid target in a confined liquid are limited to the field of interactions between laser and materials. Generally, two distinctly different definitions of so-called laser ablation in liquids are found in the present securable literature. To avoid confusion of conceptions, it is necessary to distinguish the different descriptions involved in laser ablation in liquids.

Basically, laser ablation in liquids is divided into two kinds. One is the laser ablation of liquids in a gas or a liquid environment. In other words, laser ablates a liquid at the gas–liquid interface or the liquid–solid interface. In fact, laser ablation of liquids has been intensely pursued in recent decades because of its enormous potential for technological applications such as high-temperature chemical synthesis and laser-based material processing. It exhibits

a great potential for medical applications when laser irradiation is guarded inside the human body to ablate "soft" tissue. Moreover, the technique has provided a route to understand the interaction between laser and soft or organic matter with complex structures. The second type is laser ablation of solids in liquid environments, wherein laser ablates a solid target at the liquid–solid interface. In this book, we focus on the latter, besides the relevant applications in the synthesis of nanocrystals.

Up to date, laser ablation of a solid target in a liquid environment has been widely used in the preparation of nanomaterials and fabrication of nanostructures. Remarkably, a lot of research groups in the world have been focusing on this issue, and a large variety of nanomaterials such as metals, metallic alloys, semiconductors, and polymers have been synthesized using laser ablation of solids in liquids. Accordingly, laser ablation of a solid target in a confined liquid has been demonstrated to be an effective and a general route toward nanocrystal and nanostructure synthesis, especially synthesis of nanocrystals with metastable phases such as diamond and related materials and of the immiscible alloying phase. Furthermore, laser ablation in liquids is a chemically "simple and clean" technology.

This book focuses on the fundamental concepts and physical and chemical aspects of plsed-laser ablation of solid targets in liquid environments and its applications in the preparation of nanomaterials and fabrication of nanostructures. Modification of the size, shape, phase, morphology, and composition of the nanomaterials produced can be achieved through the adjustment of laser processing parameters, which is crucial for improving the performance and hence applications of nanomaterials. The areas of focus include basic thermodynamic and kinetic processes of laser ablation in liquids, and its applications in metal and metal oxide nanocrystal synthesis as well as semiconductor nanostructure fabrication.

The book comprises theoretical and experimental analysis of laser ablation in liquids, research methods, and preparation techniques. It not only presents to the readers an overview of ongoing research activities worldwide on laser ablation in liquids and applications in the synthesis of nanomaterials, but also

provides expert guidance on their future research endeavors and developments.

Many people have contributed to this book. I would like to thank the authors, leading experts in their respected fields, who devoted their efforts to write excellent, state-of-the-art review chapters for this book. I am also grateful to Sarabjeet Garcha, the editorial manager at Pan Stanford Publishing, for his patience and skill in handling the technical issues related to the publication. Finally, I would like to thank the many unnamed editorial and production staffs at Pan Stanford Publishing for their expert work.

Guowei Yang
October 2011

Laser ablation in liquids has been studied intensively in recent years, because it has shown great potential in laser material microprocessing, including the preparation of nanomaterials and the fabrication of nanostructures. Thus, pursuing physics and chemistry of laser ablation in liquids and exploiting new applications in nanomaterials synthesis is a very important challenge.

This book is the first comprehensive and authoritative reference to consider both fundamental and applied aspects of laser ablation of a solid target in liquid-in-liquid environments. Up to date, laser ablation of a solid target in a liquid environment has been widely used in the preparation of nanomaterials and fabrication of nanostructures. Remarkably, a lot of research groups in the world have been focusing on this issue, and a large variety of nanomaterials such as metals, metallic alloys, semiconductors, and polymers have been synthesized using laser ablation of solids in liquids. Accordingly, laser ablation of a solid target in a confined liquid has been demonstrated to be an effective and a general route toward nanocrystal and nanostructure synthesis, especially synthesis of nanocrystals with metastable phases such as diamond and related materials and of the immiscible alloying phase. Furthermore, laser ablation in liquids is a chemically "simple and clean" technology.

The book focuses on the fundamental concepts and physical and chemical aspects of pulsed-laser ablation of solid targets in liquid environments and its applications in the preparation of nanomaterials and fabrication of nanostructures. The areas covered include basic thermodynamic and kinetic processes of laser ablation in liquids, and its applications in metal and metal oxide nanocrystal synthesis as well as semiconductor nanostructure fabrication. In-depth theoretical and experimental analyses of laser ablation in liquids, research methods, and preparation techniques add to the appeal and relevance of the text.

Guowei Yang received his PhD in materials physics and chemistry at Tsinghua University, China, in 2000. He held a postdoctoral position at the Department of Physics and Frederick Seitz Materials Research Laboratory of the University of Illinois at Urbana–Champaign, USA, before joining the materials science faculty at Sun Yat-sen University, China, in 2002, where he is currently a Cheung Kong Professor of Materials Physics and Chemistry and director of the Nanotechnology Research Center. Prof. Yang also served as a guest professor in the Department of Physics of the Universität Leipzig, Leipzig, Germany (2004), the Centre d'Elaboration de Matériaux et d'Etudes Structurales, CNRS, Toulouse, France (2006), and the National Institute for Materials Science (NIMS), Tsukuba, Japan (2009). His research interests lie in the experiments and theory of nanomaterials and nanostructures. In experimental, Prof. Yang specializes in the growth, properties, and applications of optoelectronic nanomaterials, especially laser-based nanomaterial processing. In theoretical, he focuses on the thermodynamic nucleation and kinetic growth of the metastable phase at the nanometer scale, and the surface and interface energy of nanomaterials.

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