PROCEEDINGS OF SPIE

Laser-based Micro- and Nanopackaging and Assembly V

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25–27 January 2011
San Francisco, California, United States

Sponsored and Published by
SPIE

Volume 7921

Proceedings of SPIE, 0277-786X, v. 7921

Please use the following format to cite material from this book:
Author(s), "Title of Paper," in *Laser-based Micro- and Nanopackaging and Assembly V*, edited by Wilhelm Pfleging, Yongfeng Lu, Kunihiko Washio, Jun Amako, Willem Hoving, Proceedings of SPIE Vol. 7921 (SPIE, Bellingham, WA, 2011) Article CID Number.

ISSN 0277-786X
ISBN 9780819484581

Published by
SPIE
P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445
SPIE.org

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

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Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

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The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

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Introduction

Today, leading designs and applications are progressively being based on micro- and nanosystem technologies because of their novel and significantly improved physical, chemical, and biological properties and phenomena. Advanced laser-based micro- and nanopackaging and assembly is in strong demand by high-tech industries to be used for specialized prototypes and high-throughput devices with micro- and nanostructures to realize electronic, photonic, mechanical, fluidic, chemical, and biological functionalities. However, the realization of such devices or functional prototypes imposes new challenges for patterning, packaging, and assembly.

Miniaturization of the functional devices and systems significantly increases the complexity of their design and fabrication. Due to the continually increasing complexity of device structures, processing needs for a wide variety of materials are required, leading to new applications and fields of research. However, these new requirements impose new challenges in developing appropriate assembly and packaging technologies. The laser-induced modification of material properties on the micro- or nanoscale becomes increasingly important for some applications (e.g. photovoltaics, batteries). On one hand, undesirable material and surface modifications, such as chemical or heat-affected structural changes, must be avoided. On the other hand, laser-assisted processes, such as annealing, doping, and refractive index changes, can be used to obtain new and advanced materials and functionalities for larger areas as well as those on the micrometer and nanometer scale. There is also a strong demand to transfer these novel laser-based processing technologies to industry-relevant applications with high efficiency and throughput.

The Laser-Based Micropackaging conference series was established in 2002. In 2007, the conference was renamed "Laser-Based Micro- and Nano-Packaging and Assembly (LBMP)" to reflect the increasing relevance of nanometer-scaled structures. The aim of this conference is to bring together scientists and engineers working on application-oriented aspects of laser-based micro- and nanopackaging for electronic, photonic, mechanical, chemical, biological, bioactive, or biocompatible devices, including MEMS/bio-MEMS, MOEMS, and OLEDs. Because of the great economical demand, material processing is playing an increasingly important role in current and future LBMP conferences, along with new "green technologies" such as photovoltaics and advanced energy storage systems. Two speakers at the LBMP conference received the Green Photonics Award of SPIE which underlines the strong relevance of the LBMP conference for future oriented and ecological applications.

The LBMP-V conference was held January 25–27 as part of LASE 2011 at Photonics West in San Francisco, California. LBMP-V was comprised of 27 oral presentations by speakers from France, Italy, Japan, Switzerland, Germany, and the United States. The presentations represented a number of topics including: laser welding and joining, ultrafast laser, advanced laser-assisted deposition and synthesis, laser micro- and nanostructuring and modification, micro- and nanomachining, batteries and thin films, direct-write processing and surface modification, and photovoltaics. The photovoltaics session was jointly organized with Conference 7920: Laser Applications in Microelectronic and Optoelectronic Manufacturing XVI (LAMOM XVI).

We would like to express our deepest gratitude to the Program Committee members and the SPIE technical staff for their great efforts during the planning and organization of LBMP-V. We would also like to thank the invited speakers and those who presented papers for their contribution to the success of the conference. All the manuscripts were peer reviewed in order to publish high-quality conference proceedings.

Wilhelm Pfleging
Yongfeng Lu
Kunihiko Washio

Laser based manufacturing of shunt lines for OLED lighting

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EXTENDED ABSTRACT

OLED lighting is a new player in the arena of high efficiency, long lived light sources. In contrast to inorganic LED, OLED is a technology to realise large area light sources. The base technology is already in wide use for displays like mobile phones or PDA's. One of the main attention points in this technology is the need to realise large are light sources by at the same time maintaining low cost as we have to compete with classical light sources. The main cost driver in OLED lighting is the substrate compromising a glass plate, a transparent conductive oxide (TCO) and a metal grid to support current distribution in the area. These substrates are manufactured using passive matrix display technology. The glass plate is coated with a layer of the conductive oxide and a second layer of the metal which is then sequentially structured again using photo lithography. The TCO acts as transparent anode of the OLED device. In subsequent processes, the organic layer stack and a metal cathode are deposited via thermal evaporation in vacuum. Afterwards, the device is encapsulated with cavity glass.

In collaboration with the Fraunhofer ILT group we have developed a new technology to realise metal shunt lines on a transparent electrode. This process makes use of a pulsed laser system used to melt and partially vaporise metal from a carrier foil. This metal is transferred onto the OLED substrate. In order to assure good line definition, a shadow mask defining the deposition area and reducing overspray is placed between the carrier foil and the glass substrate. Alternatively, the carrier foil is structured in such a way that it acts as a shadow mask by itself (figure 1). Using this technology it is possible to realise shunt lines of copper and aluminium with a conductivity close to bulk at high transfer rates.

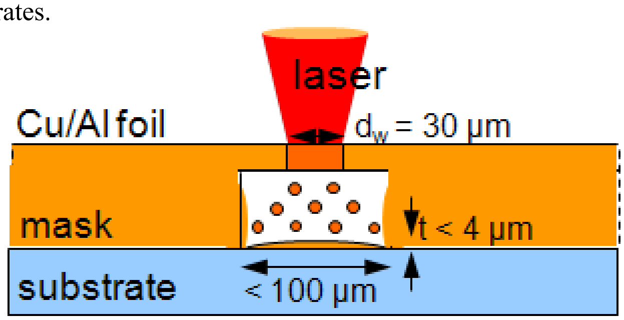

Figure 1 Working principle for the metal transfer process using a carrier foil with structures that act as a mask

Achievable metal line widths are below 100 microns, which is sufficient for OLED lighting applications. It is possible to produce overlapping and crossing lines as used in a typical grid to improve the current distribution. It is possible to increase the conductivity of metal lines by depositing multiple layers. Processing speeds up to about 2.5 m/min were realised with optimized power and pulse repetition rate. For testing the process with regard to industrialization, various process parameters were varied and the influence on the quality of the deposited metal lines was tested. Typical thicknesses for the shadow mask are in the range 50 microns, and a variation of 10 microns in both directions has no significant influence. Slit widths between 60 and 120 microns were tested for the shadow mask without a negative impact on the specific resistivity of the deposited lines. Also the results for a 5 % variation in power or scan speed (without changing the other parameters) were within the tolerance range. However, it is important to have a precise alignment between the laser focus and the center of the mask slits for high quality results.

The work on the process will be continued. One of the remaining challenges is the production of structured carrier foils which simultaneously act as carrier and mask. This work has received funding from Germany‘s Federal Ministry for Education and Research (BMBF) within the „OPAL 2008“ project.