MICRO/NANO MATERIAL PROCESSING

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Summary

The chapter gives a brief introduction into microtechnology and nanotechnology. Thanks to the rapid development of cost-effective processes for mass production of microparts, the irrepressible crossing from precision engineering to microtechnology has been continued. Continuous development has one consequence - graduate crossing to the field of nanoproducts. Scientists have succeeded in developing tools that enable them to create functional nanostructures by transposition of individual atoms and molecules. Development of these new fields that are the result of joined work of various experts also requires the new approach to education of technicians, as well as medics, biologists and others.

1. Introduction

In recent years, new technologies like microtechnology and nanotechnology followed the development of microelectronics. Thanks to the rapid development of cost-effective processes for mass production of microparts, the irrepressible crossing from precision engineering to microtechnology has been continued. No effort is spared in development of micromechanics and manufacture of heterogeneous microsystems, as well as in

integration of microproducts into macroscopic systems and development of biochip production.

Continuous development has one consequence - graduate crossing to nanoproducts field. Scientists have succeeded in developing tools that enable them to create functional nanostructures by transposition of individual atoms and molecules. Completely new potential can be achieved by application of self-organizing growth of complex molecular and biological systems.
Development of these new fields that are the result of joined work of various experts also requires the new approach to education of technicians, as well as medics, biologists and other. A brief introduction to this subject with links to further reading is provided in this article.

2. Micro- and Nanotechnology

2.1. Microtechnology

A microsystem is defined as an intelligent miniaturized system computing sensing, processing and/or actuating functions. These would normally combine two or more of the following: electrical, mechanical, optical, chemical, biological, magnetic or other properties integrated onto a single chip or a multi-chip hybrid. [1]

Properties of microtechnology are small dimension of elements, their serial production with high accuracy and precision.

Figure 1 shows world development of microtechnology and microelectronics. Development of microelectronics started in the mid 1960s, twenty years before microtechnology. In the second half of 1990s microelectronics took the leading roll among all productions techniques. [2]

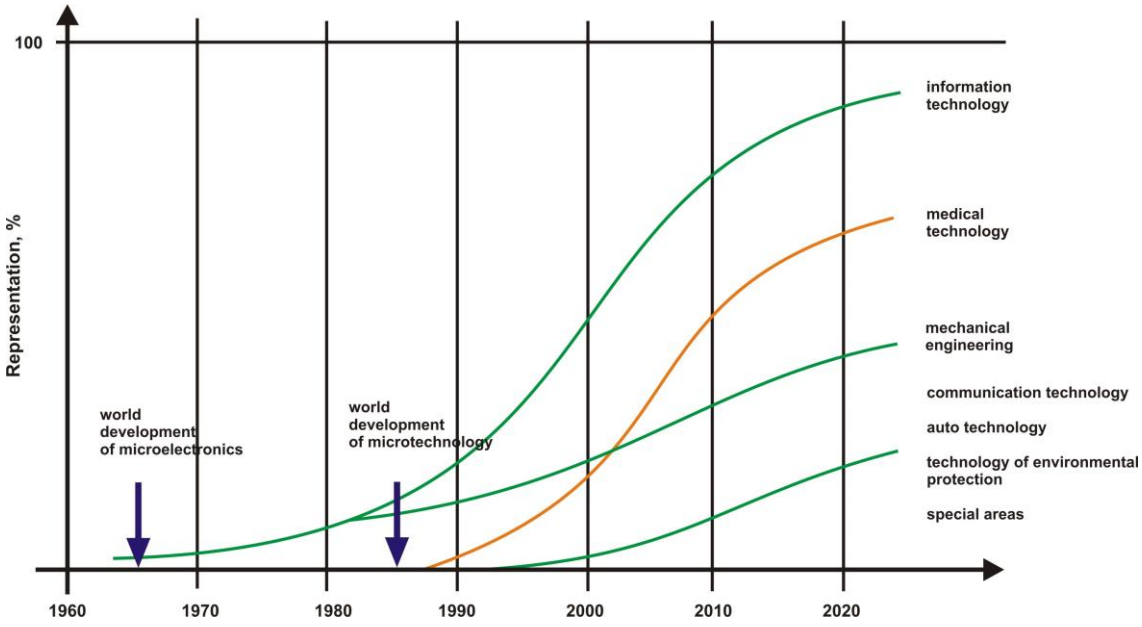

Figure 1. Development of microtechnology vs microelectronics [2]

The idea that microelements are applied specific for microsystems is wrong, but it must be noted that applying microelements allow development and production of macroproducts.

2.1.1 Processes of Microtechnology

2.1.1.1 Machining

For that purpose ultra precision machines (Figure 2) were developed with high accuracy in sub-micrometer area, what allowed that optical quality of surface with extraordinary stiffness of machining system can be achieved. [1]

Methods are: turning, planing, milling, drilling, grinding and eroding (Figure 3). With this process complex geometry of parts may be manufactured. For example: optical parts, bearing, micro-propeller (figure 4) or test parts.

Figure 2. Example for machine for microtechnology [3]

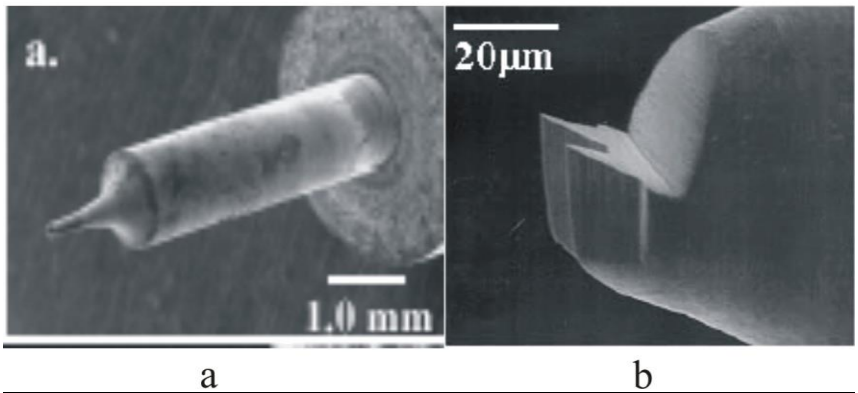

Figure 3. Tools for micro processing (a - milling, b – turning) [3]

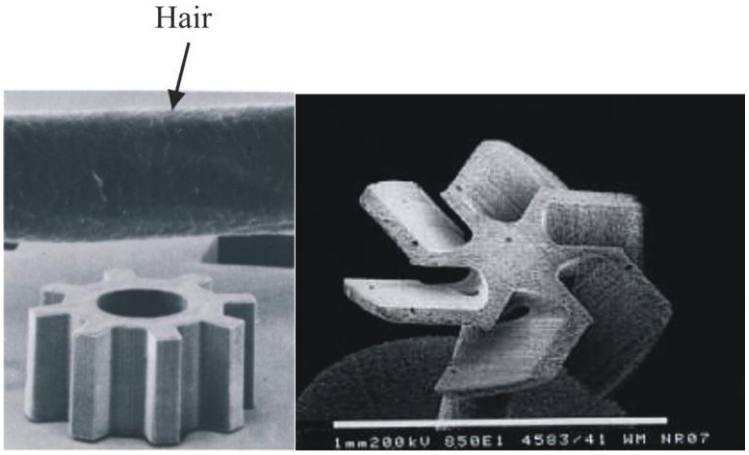

Figure 4. Microproduct (a - bearing, b – micro-propeller produced by EDM, diameter 1 mm) [3]

2.1.1.2 LIGA process

LIGA process (Figure 5) represents a set of activities which imply joint of lithography, electroforming and molding. [4]

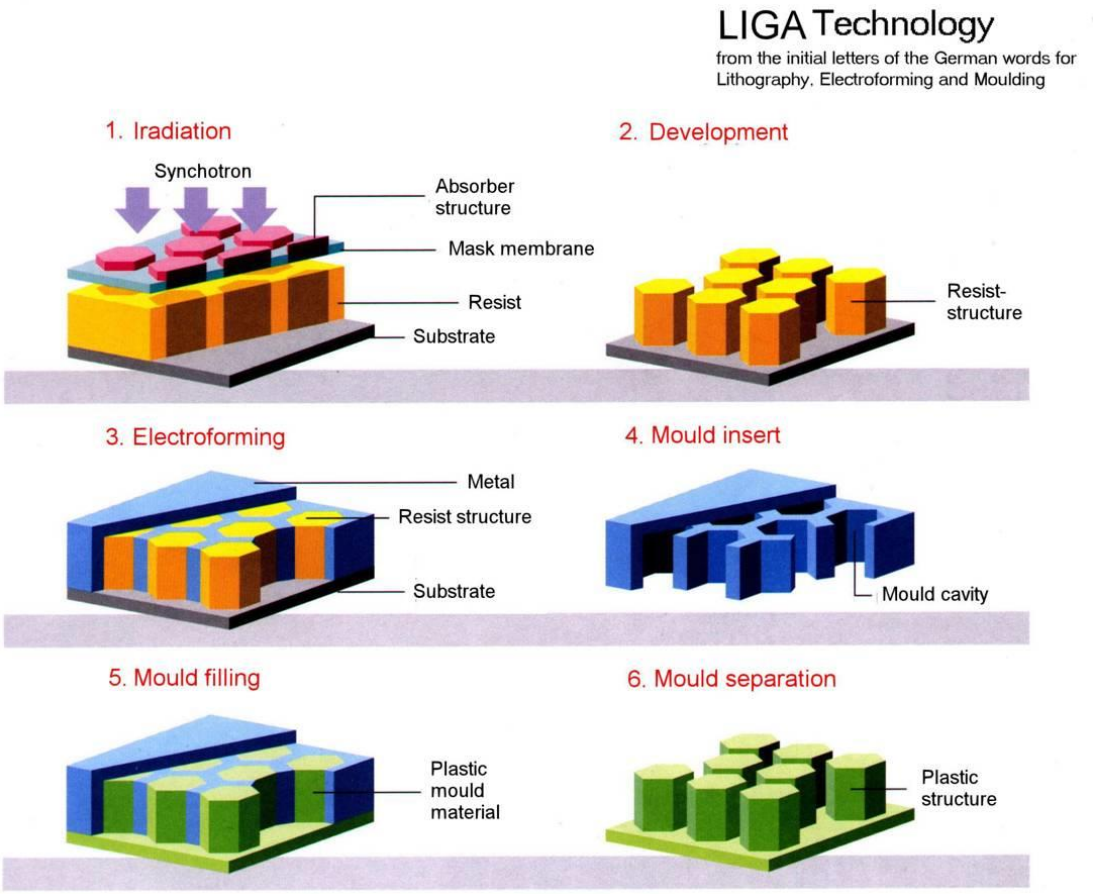

Figure 5. LIGA process [4]

For production of molds special type of radiation (e.g. X – rays and UV -rays) during the lithography can be used, and then with process of electroforming a design of micro-mold can be achieved. With LIGA process different metals, alloys, polymers and ceramics can be used.

Products of LIGA process are: parts for various micro-engines and micro-machinery, watch micro-mechanisms, micro-optical devices, microsensors etc. Size of those products is from several micrometers to several millimeters. Roughness of surface is around 100 nm. [4]

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Biographical Sketches

Mladen Šercer was born in Zagreb, Croatia on September 29th, 1953. He graduated from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Croatia in 1977. He obtained a Master of Science (M.Sc.) degree in 1984 from the Faculty of Technology, University of Zagreb and a PhD degree in 1989 from the Faculty of Mechanical Engineering and Naval Architecture, in the field of mechanical engineering (polymer technology) from the University of Zagreb.

He worked at the Faculty of Mechanical Engineering and Naval Architecture since 1978, first as an assistant, from 1985 as scientific research assistant, from 1989 as assistant professor, from 1996 as associate professor, and since 2001 as full professor in the field of mechanical engineering, section of *Mechanical Technologies and Processing Systems* at the Department of Technology. In June 2006 he was promoted in permanent position of full professor. Since 2001 he is the head of the Chair for Polymer Processing and since 2006 also the head of the Department of Technology. From 1984-1985 he researched at Institute for Polymer Processing (Institut für Kunststoffverarbeitung - IKV), Aachen, Germany, sponsored by German Academic Exchange Foundation (Deutscher Akademischer Austauschdienst - DAAD). He published as author and co-author several books and monographs and number of articles in scientific journals and at international symposia. He has also delivered a number of lectures in country and abroad. In his professional, teaching and scientific work he focuses mainly on polymer processing technology, development and designing of polymeric parts and molds, rapid prototyping and recycling of polymers.

Prof. Šercer is associate member of the Academy of Technical Sciences of Croatia. He is a member, founder and secretary of the Society of Polymer Engineers, Zagreb (Croatia). He is a member of the Society of Plastics and Rubber, Zagreb (Croatia), the Croatian DAAD club and Polymer Processing Society, Akron, USA. He was the editor of the column *From the World of Plastics and Rubber*, editor for *Categorized Articles*, and editor-in-chief of the journal *Polimeri (Polymers), Zagreb (Croatia)*.

Pero Raos was born in Split, Croatia on May 3rd, 1961. He graduated from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Croatia in 1984. He obtained a Master of Science (M.Sc.) degree in 1987, and a PHD degree in 1991 in the field of mechanical engineering (polymer technology) from the same University.

In November 1993 he became the assistant professor of the Mechanical Engineering Faculty of Slavonski Brod at University of Osijek, Croatia. In January 1998 he was entitled as associate professor and in November 2001 as full professor at the same Faculty. In February 2006 he was promoted in permanent position of full professor. Since June 2005 he is the head of the Department of Technology. From 1989-1990 and 1993-1994 he researched at Institute for Polymer Processing (Institut für Kunststoffverarbeitung - IKV), Aachen, Germany, sponsored by German Academic Exchange Foundation (Deutscher Akademischer Austauschdienst - DAAD) and Alexander von Humboldt Foundation. In 1993 he researched shortly at Institut de Génie Civil, Liege, Belgium. He is the author and co author of several books and a number of scientific and professional papers. He has also delivered a number of lectures in country and abroad. In his professional, teaching and scientific work he focuses mainly on polymer processing technology, development and designing of polymeric parts and molds, numerical methods and application of finite element methods in designing and application of adhesive bonding technology.

Prof. Raos is a member of the Scientific Council for Technical Sciences of the National Science Council of the Republic of Croatia. He was the Secretary General of Plastic and Rubber Engineers Society of Croatia (1992-1993). Prof. Raos is the president of Telemedicine Association of Zagreb (Croatia) and a member of Polymer Processing Society, Akron (USA), and European Scientific Association for Material Forming (France), Croatian Humboldt Club, Zagreb (Croatia), Society of Polymer Engineers, Zagreb (Croatia), Croatian Maintenance Society, Zagreb (Croatia) and Croatian System Society, Zagreb (Croatia). He is editor-in-chief of the journal Technical Gazette (Croatia).