SUMMARY

„Ceramic sensors and microsystems utilising optical detection methods"

The development and manufacture of miniature analytical devices that combine several functionalities of a traditional laboratory, reduce the amount of consumed reagents, and simplify and shorten the duration of the analytical process is one of the important contemporary research topics. Numerous research activities in this field relate to the development of manufacturing techniques, the search for new materials and new design solutions, as well as the development of new, increasingly accurate and sensitive measurement methods. Among others, low-temperature co-fired ceramic technology is used to manufacture such miniature analytical systems.

The first subject presented in detail in the thesis is the use of sol-gel layers as a special coating for LTCC ceramics. By applying such coating, the roughness and wettability of LTCC ceramics are improved. This significantly reduces the adsorption of dyes or biological substances on the surfaces of channels, mixers, or detection and reaction chambers as well as the flow resistance in liquid channels. Furthermore, in collaboration with the Department of Molecular Techniques of Wrocław Medical University, the effect of sol-gel layers on the inhibition of the polymerase chain reaction by LTCC ceramics was determined. Sol-gel layers were found to enhance the applicability of analytical microsystems made of LTCC ceramics for biological and medical diagnostics.

To confirm the above conclusions, the original design and technology of ceramic liquid microsystems utilising the fluorescence phenomenon was presented. A comparison was made between sensors in which the ceramic structures were coated with a sol-gel protection layer and sensors without this layer.

The second investigated subject concerned the conception, design, fabrication and characterisation of original ceramic sensors and microsystems utilising optical detection methods. In addition to the liquid microsystem already presented, these were a miniature ceramic cell analyser and a liquid microsystem based on the phenomenon of light absorption. A miniature ceramic cell analyser was designed for the quantitative determination of biological samples in the form of *Escherichia coli* and *Saccharomyces cerevisiae* cells. This was studied in collaboration with the Hirszfeld Institute of Immunology and Experimental

Therapy of the Polish Academy of Sciences in Wrocław and the Helmholtz Centre for Infection Research in Braunschweig (Germany).

The universal ceramic liquid microsystem, based on the phenomenon of light absorption, employed three fast-switching, different intensity-controlled light sources. Its parameters were determined by measuring the absorbance of visible radiation through solutions of potassium permanganate and rhodamine 6G at different molar concentrations.

A characteristic feature of the developed structures was the integration of relatively inexpensive and broadly available electronic and optoelectronic components into these structures. With the presented sensors, it is possible to determine the concentration of test substances by measuring their fluorescence intensity or light absorbance.

The dissertation is complemented with a description of the ceramic-polymer valve and microfluidic pump, whose operation is based on electromagnetic phenomena.

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