DESCRIPTION FOR THE GENERAL PUBLIC

One of the main factors that enables the development of the modern world, is on-going miniaturization. Thanks to that the parameters of tablets or smartphones available in the market are comparable or even better than desktops which were available few years ago. While research on high frequency systems enabled for wireless transmission not only of voice and text messages, but also video and data at speeds comparable to wired Internet.

Miniaturization has left its mark not only in the field of electronics. In the nineties arose the concept of miniaturized μTAS (*Micro Total Analysis System*) and LoC (*Lab-on-Chip*) devices. The purpose of these microsystems would be conducting various chemical and biochemical analysis in continuous mode and in an automated manner. The volume of analyzed samples would be micro- or nanoliters. This would reduce the time and cost of a single analysis. Moreover, the automation would allow the maintenance of such equipment in a manner much simpler and without the need of qualified personnel.

Typical analytical microsystem can be divided into several components: transport of sample, sample preparation and pre-detection system. Transport samples is carried out using microvalves or micropumps, and the preliminary preparation of the sample is performed by microreactors or micromixers. At the end of the sample is characterized using a detection system. This system can measure a light signal (eg. fluorescence) or electric (measurements of current, voltage, resistance etc.).

Initially these microsystems were made of silicon or glass. This was due to the fact that researchers and engineers managed to master the technology to manufacture micromechanical devices with very good accuracy and repeatability. Sometime later, a group of materials to fabricate μTAS and LoC joined Low Temperature Co-fired Ceramics.

The origins of this technology dates back to the eighties of the twentieth century. It was developed to increase the density of connections in large-scale systems integration. In contrast to the high temperature of multilayer systems, by reducing the firing temperature from 1600°C to less than 900°C, it was possible to use materials used for conventional thick-film systems (eg. conductive paste based on silver). The LTCC-based devices characterized with a much better performance than those which content tungsten or molybdenum. Moreover, electrical interconnections and passive components (resistors, capacitors, inductors) can be easily integrate inside the multilayer ceramic module MCM-C (*Multichip module - ceramics*). The active components (transistors, LEDs, integrated circuits etc.) can be mounted on the surface of the LTCC module using standard methods of electronic assembly.

Thanks to the ease of processing the raw LTCC material, it is possible to fabricate spatial structures (channels, cavities, cantilevers etc.) inside the multilayer module. There are also methods of bonding LTCC with other materials used in microelectronics (glass, silicon, polymers). To all these benefits must be added the fact that the ceramic retains its properties over a wide temperature range, and is resistant to most acids and bases.

Not only mechanical parameters are the strong point of LTCC materials. The main use of systems produced by this technology are wireless communication systems (microwave). In such systems, in addition to reliability, an important issue is the loss of energy in the system. They result mainly from losses in conductors and dielectric (substrate). With increasing frequency begins to dominate losses in the substrate. Literature notes examples of systems that have worked for several tens of gigahertz frequencies. Microwave radiation can be applicable not only in telecommunications. Percy Spencer was the first who found out about this in 1945. When he worked on radar systems to his surprise he noticed that chocolate candy bar had melted in his pocket. Further experiments showed that the cause of this was the effect of microwaves, which led to the creation the first microwave oven in 1947. The first patent for carrying out a chemical reaction in the presence of microwaves was awarded in 1968 by the Dow Chemical Company. First reports in the scientific literature on synthesis of chemical compounds enhanced by microwaves was provided in 1986. Since that time articles in well-known scientific journals and books devoted to the application of microwaves in chemistry, for example. *"Microwave Heating as a Tool for Sustainable Chemistry"*, edited by Nicholas Leadbeater were written. There are described examples of the chemical processes, wherein the microwave heating allows to increase the reaction rate, even several dozen times.

The aim of the research that we set ourselves, is the development of microfluidic systems made in LTCC technology where electromagnetic energy in the form of microwaves would be used at the stage of preliminary sample preparation and for detection of the analyte.