SOME ASPECTS IN THICK-FILM CAPILLARY PRODUCTION

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One of trends is integration simply TFT sensor with channels, filters, capillaries or micro pumps. The experimentally made channel and capillaries by thick-film technology are the main goal of this work. The capillaries are usually made by special membrane, metal etching, by LTCC. This paper is focused on simple experiments with the capillary fabrication using pastes overlaying on two separate substrates that are then joined together forming up the capillary. Some aspects about problem channels and capillaries made by thick-film technology are discussed in this paper.

Keywords: thick-film, channel, capillary

1. INTRODUCTION

At the beginning the thick-film technology (TFT) was focused on the production of hybrid integrated circuits [1]. The basic use of thick film technology was in the production of special integrated circuits, small series of nonstandard integrated circuits and prototypes [2]. At present time the TFT is partially suppressed in its classical meaning as a tool of preparation of very small electronic details by SMT. Therefore the technological importance of TFT has been shifted significantly to high reliability applications, military and nonconventional applications. The nonconventional applications use the basic ideas of TFT, namely the screen printing as a method of active layer preparation and enhance the technology to printing of optically and chemically active layers. The examples of nonconventional applications include displays, heat spirals for pots, antennas for chip cards [3], fuses and especially sensor systems. The main advantage lies in low price, very good mechanical and thermal properties, good electrical properties and small scale batch production. They have optimal properties for design of simple electrochemical sensor and analytical device. Nowadays, special sensor systems and analytical devices are more complicated. One of trends is integration simply TFT sensor with channels, filters, capillaries or micro pumps.

The experimentally made capillaries by thick-film technology are the main goal of this work. The capillaries are usually made by special membrane [4], metal etching, by LTCC [5]. We will be focused on experiments with the capillary fabrication using pastes overlaying on two separate substrates that are then joined together forming up the capillary.

2. PRINCIPLE

The basic simple idea of thick-film channel fabrication process is shown in fig. 1. The process is based on two steps. In the first step, two substrates with mirrored topology using repeated overprinting and firing are made to create sufficient channel height which is equal to number of overprinted layers (fig. 1a). In the second step, the bottom substrate is overlapped by the second one and then fired to join them together. This step forms up the channel as is shown in the figure 1b.

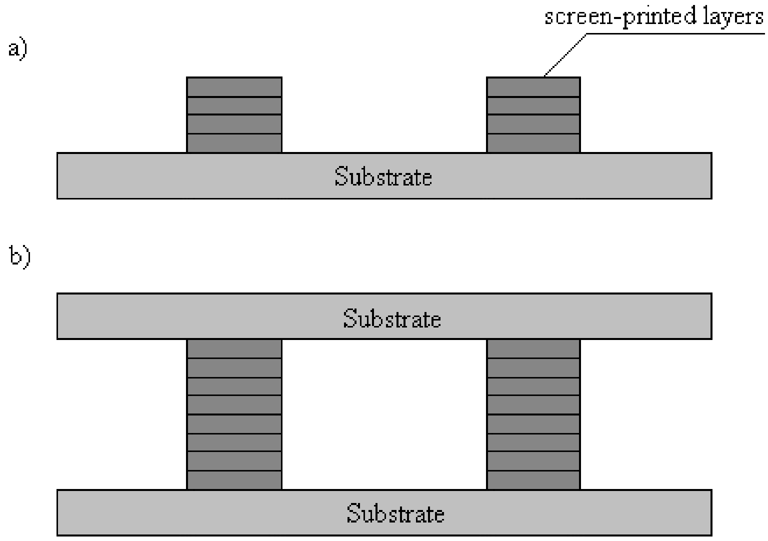

Fig. 1: Basic idea of thick-film channel created as multilayer structure

3. TOPOLOGY DESIGN

Substrate topology is designed from two parts as is shown in fig. 2. First part is designed for testing dependence of wall merge on number of layers; second part is designed for capillaries creation. The gap width is varied from 20µm to 400µm in first part. The capillary width is varied from 100µm to 400µm in second part. The distance between capillaries is 1000µm.

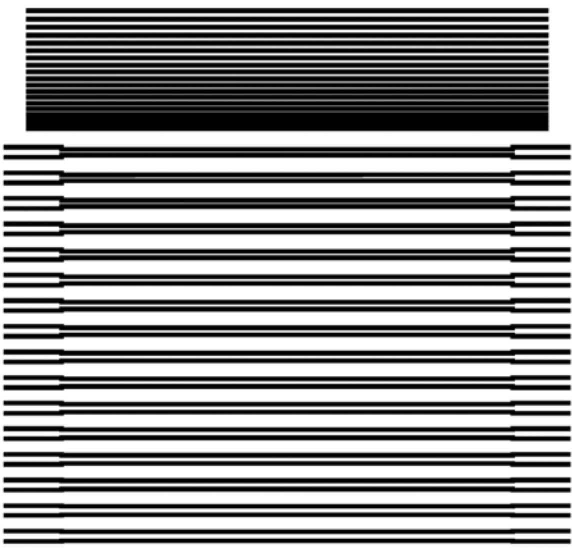

Fig. 2: Topology design for experiment

4. Results and discussion

4.1 Printing repeatability

In the test of printing repeatability the dependence of a defect and wall merge on gap width were tested. The obtained dependences are shown in the fig. 3 and fig. 4.

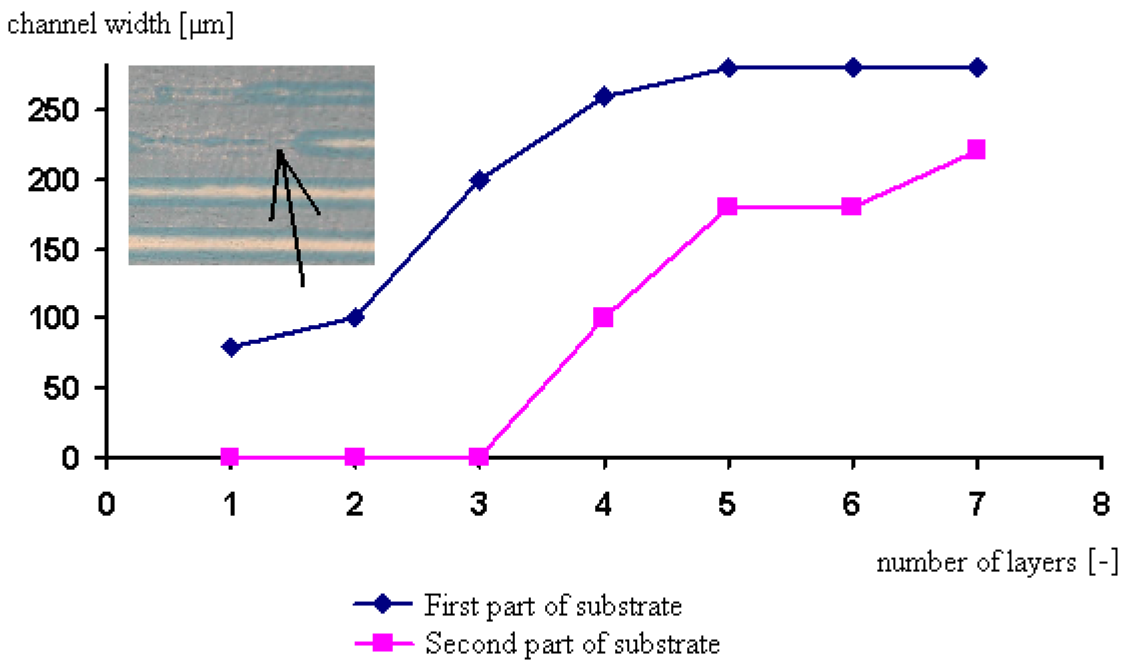

Fig. 3: Dependence of wall merge on number of layers for first and second part of substrate

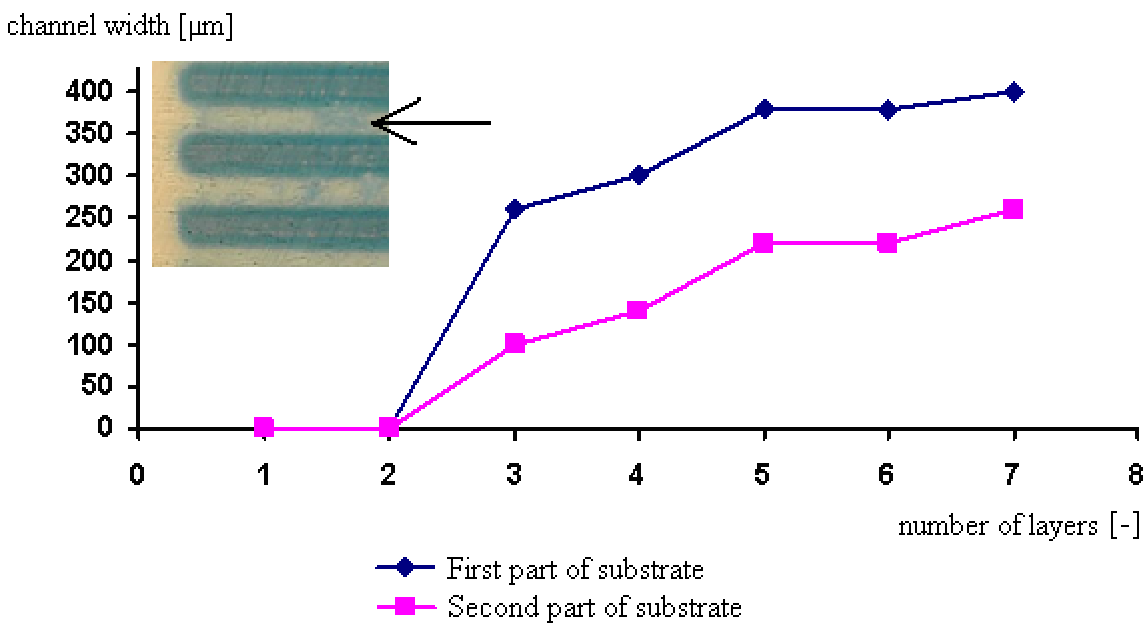

Fig. 4: Dependence of defect on number of layers for first and second part of substrate

From the figure 3 and 4 it is clear that wall merge on the first part of substrate in case of channel width from 20 µm to 80 µm was observed after first layer screen-printing. Next reprints lead to wall merge. After last print (seventh layer screen-printing) the channel of 400μm width was well created only on the first part of the substrate (without defect and wall merge). The channels from 280 μm to 400 μm width were realized successfully after last seventh reprint too. Lower dimension channels were not realized successfully. It was caused by the fact that the paste underflows the screen due to insufficient adhesion of screen on the edge of the channel walls. Therefore at the simple motives where channel distances are higher, the designed line width can be set from 300 μm. In case of complicated motives the designed line width should be set from 400 μm.

4.2 Joining of substrates

In this step, one of substrates was turned upside down, placed over the bottom substrate and fired. All created capillaries were examined after the firing process. It was found that just capillary of 400μm width (fig. 5) and capillary of 1000μm with (fig. 6) were created well. Success of fabrication process was partially ensured by sufficient spaces between capillaries. During the final firing process, there was found a problem with reconciliation of printed layers of the substrates as is shown in figure7.

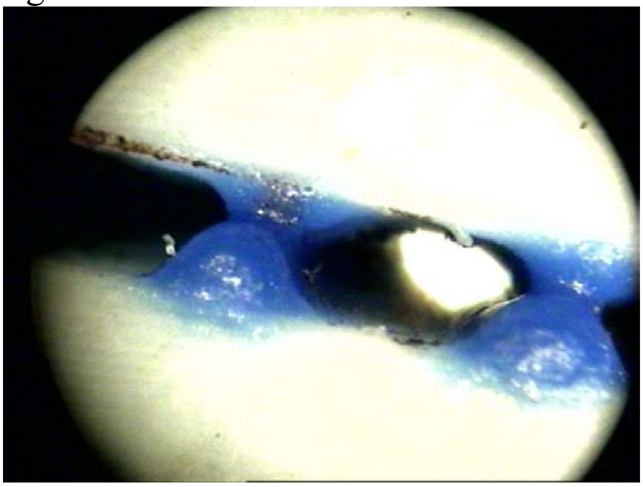

Fig.5: Well fabricated capillary (400μm width)

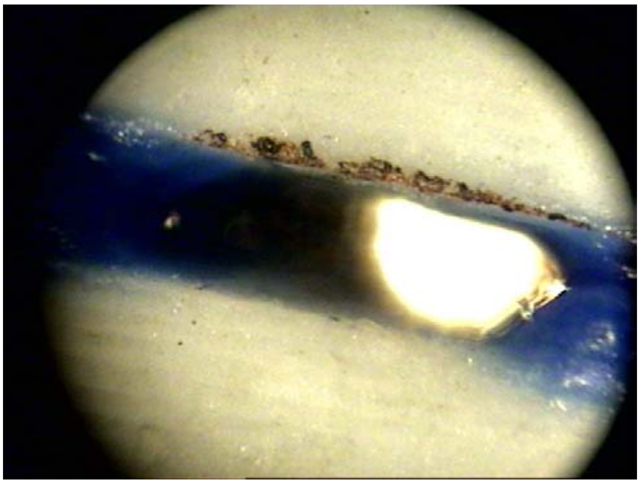

Fig. 6: Well fabricated capillary (1000μm width)

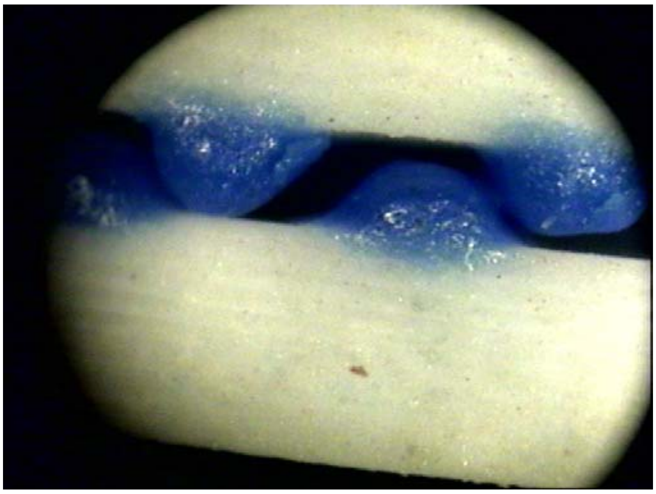

Fig. 7: Shift of the substrates during final fabrication process

5. CONCLUSIONS

Special sensor systems and analytical devices are often complicate systems, which containing channels, filters, pipes or micro pumps. The main goal of this work was the experimentally made capillaries by thick-film technology, by joining of two overlapped substrates. Capillaries were well created for 400µm and 1000µm only. Basic problem was reconciliation of printed layers of the substrates. In the reprinting test seven layers were overprinted. After last print (seventh layer screen-printing) the channel of 400µm width was well created only on the first part of the substrate (without defect and wall merge). The channels from 280 µm to 400 µm width were realized successfully after last seventh reprint too. It was caused by the fact that the paste underflows the screen due to insufficient adhesion of screen on the edge of the channel walls. Therefore at the simple motives where channel distances are higher, the designed line width can be set from 300 µm. In case of complicated motives the designed line width should be set from 400 µm.

ACKNOWLEDGEMENTS

This work was partially supported by Grant Agency of The Academy of Science, Czech Republic under the contract 1QS201710508 Impedimetric microsensors with nanomachined surface of electrodes, Micro and nano sensor structures and systems with embedded intelligence (MINASES) GAČR 102/06/1624 and Czech Ministry of Education in the frame of Research Plan MSM 0021630503 MIKROSYN.

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