Wrocław University of Science and Technology

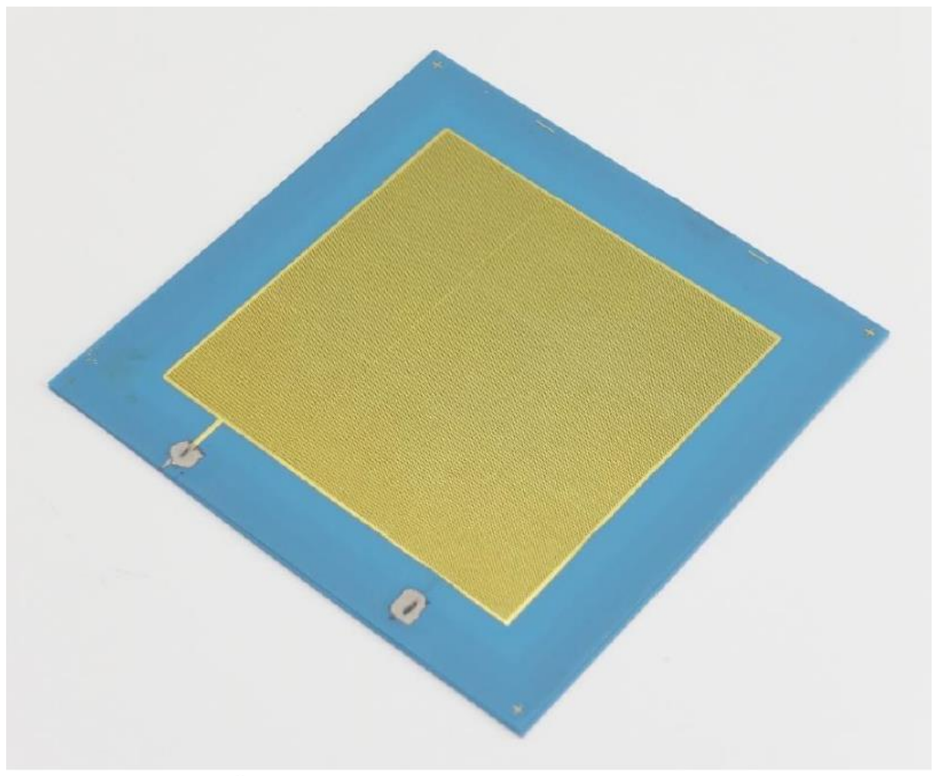
15th Pisa Meeting on Advanced Detectors
La Biodola, Isola d'Elba, May 22-28, 2022

The use of Low-Temperature Cofired Ceramics technology in Gas Electron Multiplier microstructures

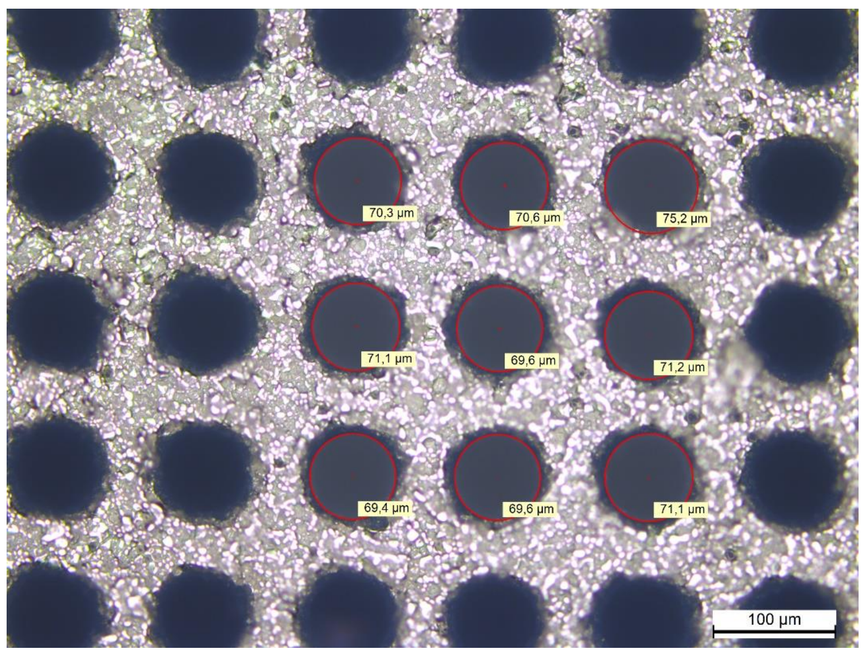
Piotr Bielówka and Karol Malecha

Wrocław University of Science and Technology, Faculty of Electronics, Photonics and Microsystems, Janiszewskiego 11/17, 50-372 Wrocław, Poland,

The research principles:
The main goal of the work is to develop a novel technique for the production of improved Gas Electron Multiplier (GEM) microstructures that are critical elements of particle detectors used for High Energy Physics research. Invented at CERN, the Micro-Chemical-Vias technology has proven optimal for producing high volumes of large size GEMs elements. It is planned to develop a technology for the production of GEMs with higher vias densities, increasing the amplification of a single structure and ensuring more excellent system reliability. Additionally, different conductive layers are planned for use.Tests were carried out using Low-Temperature Cofired Ceramics (LTCC) and various types of conductive layers.



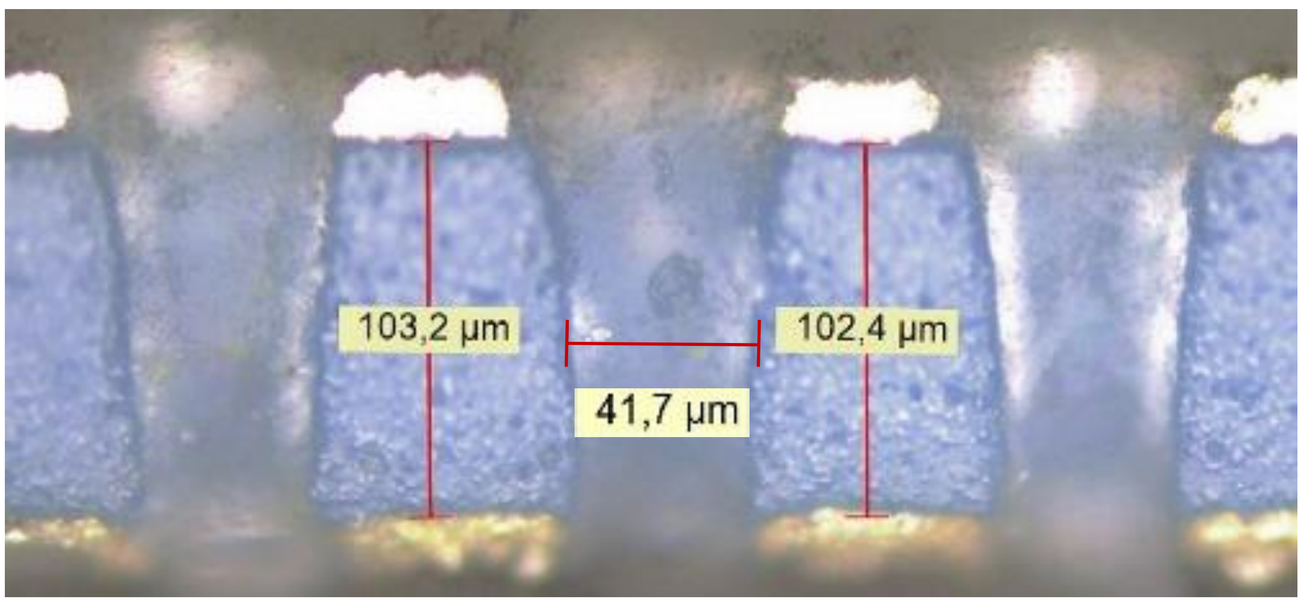
The 5x5 cm² LTCC-GEM microstructure was covered with the 5 µm thick gold electrodes.



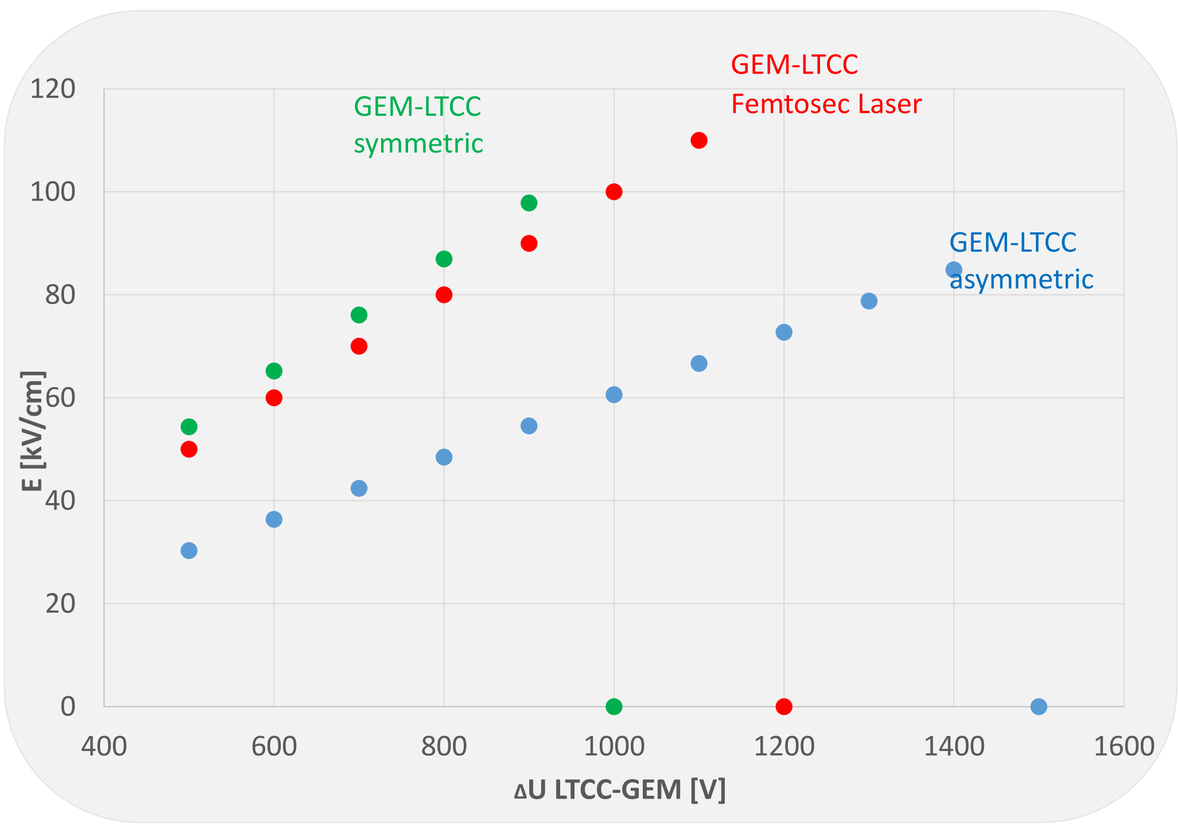
The LTTC-GEM sample was made with a femtosecond laser. The 5 µm thick electrodes are fabricated of silver.

Nr	Sample	Layer thicknes [µm]		Hole diameter [µm]		Holes pitch [µm]	Holes angles'	Operational Voltage @ 30% HR	Electrical field [kV/cm]	Metallization uniformity
		Conductive layer	Dielectric	Outer	Inner					
1.	GEM standard	2 x 5	50	70	50	140	63 deg	600 V @ 1 nA	**120**	perfect
2.	GEM-LTCC asymmetric	2 x 5	92	56	43	200	-	500V @ 11nA	54	poor
3	GEM-LTCC symmetric	2 x 10	165	85	70	160	85 deg	1400 V @ 1,2 nA	74	poor
4	**GEM-LTCC Femtosecond laser**	**2x10**	**100**	**70,9**	**65,7**	**120**	**87 deg**	**1100V @ 1,3 nA**	**110**	**medium**

List of parameters of the manufactured LTCC-GEM structures.



Metallographic cut through the GEM-LTCC sample.



Comparison of the values of electric fields generated by different LTTC-GEM microstructures

Prototypes production
The gold and silver conductive pastes were applied on the 50µm and 100µm thick ceramic substrates by a screen printing technique. A laser beam was used to produce openings at the substrates as a successive step. The quality of such prepared microstructures was investigated by measuring openings' diameters, uniformity, roughness and shapes. The samples were tested with high voltages to find the highest possible value of an electrical field.

Acknowledgement:
This work was supported by the Faculty of Electronics, Photonics and Microsystems and TTA Techtra company in a framework of the "Industrial Doctorate" scheme.

piotr.bielowka@pwr.edu.pl