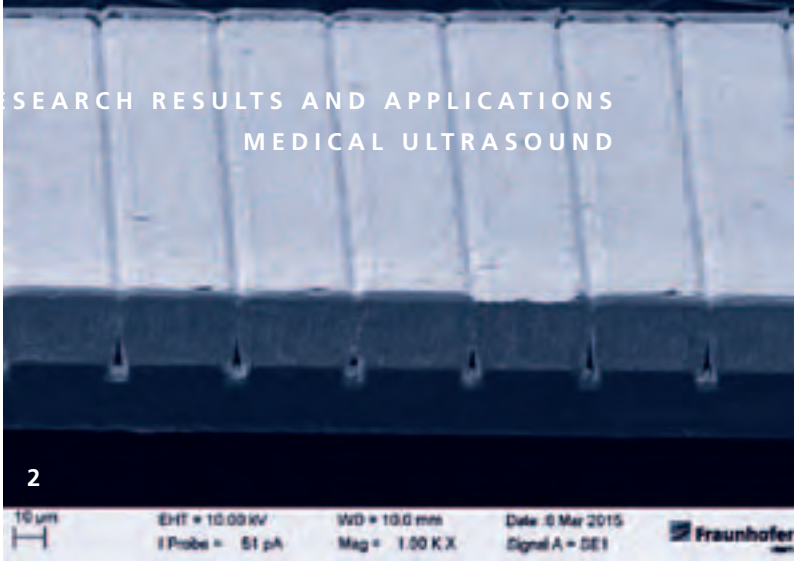
1



2

PROJECT EXAMPLE: MANUFACTURING OF HIGH-FREQUENCY ULTRASOUND ARRAYS AND DEVELOPMENT OF THE HIGH-FREQUENCY ULTRASOUND BEAM FORMER DIPHAS-HF

Starting situation

The topic of the BMBF-funded project "Columnar lead zirconate titanate for high frequency ultrasound array" was the production of high-frequency ultrasound arrays by means of hollow cathode gas flow sputtering of lead zirconate titanate (PZT) as well as the development of the corresponding high-frequency "DiPhAS" electronics. With the aid of gas flow sputtering it was possible to deposit PZT layers up to 26 µm at a sputter rate of 100 nm/min and process temperatures of 500-520 °C on 8" silicon wafers. The subsequent structuring to form arrays was carried out using lithographic techniques from the field of MEMS technology. The thus produced arrays have a centre frequency of 56.3 MHz. The PZT layers have a typical columnar structure. At 350-500 pC/N, their charge constants are very high for layer material and lie in the range of moulded parts of PZT. The relatively low process temperatures allow a simple layout without diffusion barriers to avoid lead diffusion.

The characterization and use of multi-element ultrasound transducers with centre frequencies of 50-100 MHz in real-time measurement technology and imaging are not possible with conventional ultrasound systems due to the high digitalization rate required.

Solution

The successful development of a high-frequency version of the modular "DiPhAS" platform provides the world's first ultrasound beam former with a digitalization rate of 480 MHz. Four our modular ultrasound research platform "DiPhAS", new analogue front ends were developed which offer 128 discrete digitization channels, each with 480 MSamples/s. New FPGA circuit designs were used to meet the challenging time requirements during the measurement process itself. The enormous data quantities can be transferred via high-speed connections such as PCIexpress directly to a computer for modern software-based processing and imaging. Massive parallelizations, among other things, based on arithmetical calculations on graphic cards (GPGPU with OpenCL) are used for this.

Potential

The high-frequency arrays as well as the "DiPhAS-HF" electronics are used in the areas of non-destructive material testing, (bio)medical imaging, small animal imaging and imaging of the skin, blood vessels and teeth.

The project was funded by the BMBF within the VIP framework (funding code 03V0202). The development of the gas flow sputtering of thick PZT layers and their structuring was carried out by the project partners Fraunhofer IST and Fraunhofer ISIT.

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1 *First ultrasound research platform with 128 channels and 480 MHz digitalization.*
2 *REM image of a 56.3 MHz ultrasound array.*