LASER CRYSTALLIZATION OF PRINTED PIEZOELECTRIC ACTUATOR LAYERS

Task

Microelectromechanical systems (MEMS) are becoming more and more important as electrical circuits are becoming miniaturized and increasingly integrated in a wide range of electronic devices. For microactuators, such as those used in microspeakers or micropumps, piezoelectric thin films are used as they deform mechanically when an electric field is applied. According to the current state of the art, lead zirconate titanate (PZT) is the most powerful piezoelectric functional ceramic. With conventional, mostly vacuum and mask-based processes, producing such piezoelectric thin films would be extremely time consuming and costly. By combining inkjet printing and laser-based functionalization processes, Fraunhofer ILT has been able to produce highly functional thin-film MEMS on an industrial scale with relatively little time and low costs.

Method

Specially adapted PZT inks are applied to 8" wafers with ink-jet printing processes and then crystallized by laser radiation at local temperatures of about 700 °C. By applying several PZT layers, each 10 to 20 nm thick, the project partners are able to produce actuators with total layer thicknesses of 2–3 µm.

1 Si-wafer with inkjet-printed, laser-crystallized PZT layers.

Results

The inkjet printing process could be used to deposit the inks with minimum achievable structure widths of approx. 100 µm. The piezoelectric properties of PZT layers produced by laser radiation are almost identical to those of conventional processes (e.g. furnace crystallization). However, the thermal load on the laser-processed wafer is lower. Typical deflections of an approx. 1 µm thick crystallized PZT layer are approx. 100 pm per volt of applied voltage. The required processing time can be reduced from several minutes per layer in conventional processes to a few seconds. The laser crystallization is temperature-controlled by the laser power as the regulating variable, so that temperature fluctuations are limited to a maximum of +/- 10 °C.

Applications

Piezoelectric layers can be applied in sensor technology, e.g. for measuring structure-borne noise, or in actuators in micro-pumps and relays, inkjet printers and communication technology.

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Contact

Samuel Fink M. Sc.
Telephone +49 241 8906-624
samuel.fink@ilt.fraunhofer.de

Dr. Christian Vedder
Telephone +49 241 8906-378
christian.vedder@ilt.fraunhofer.de