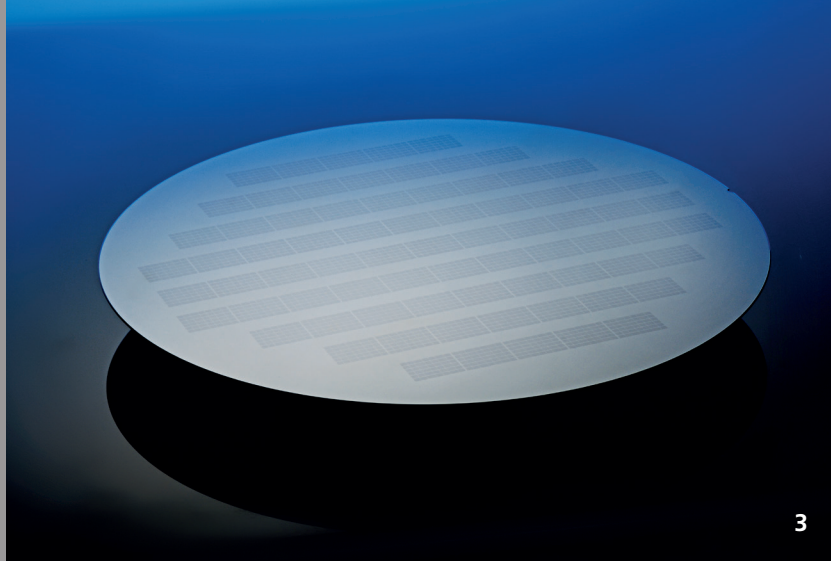

SELECTIVE LASER CRYSTALLIZATION OF THICK AMORPHOUS SILICON FILMS ON TEMPERATURE SENSITIVE SUBSTRATES

Task

MEMS sensors (micro-electro-mechanical systems) form the core of today's inertial sensors, which the industry uses in large quantities, e.g. as accelerometers in mobile devices in automobiles. To meet the ongoing trend towards increased performance with simultaneous miniaturization, Fraunhofer ILT is developing a laser-based process to produce sensor structures monolithically on the evaluation electronics, a process that can replace conventional wire- and solder-based processes. For this new process, process temperatures < 420 °C need to be maintained in the area of the integrated electrical circuits.

Method

To produce the sensor structure, Fraunhofer ILT uses CVD or PVD processes to deposit amorphous silicon layers with thicknesses in the range of 10 µm on the circuit-carrying wafers at temperatures of up to 400 °C. Laser processing is then employed to crystallize the layers and, thus, increase the electrical conductivity. The thermal impact on the circuits is reduced as compared to the alternative processes thanks to the local selectivity and high heating and cooling rates achievable by laser processes. Mechanical stresses in the wafer are reduced by means of adapted thermal management. Subsequently, sensor units are released from the functionalized layers using classical microelectronic manufacturing processes.

Results

Thanks to the newly developed laser process, the layer resistances can be lowered by more than four orders of magnitude down to < 0.05 Ω*cm (50 Ω/sq at 10 µm layer thickness). Thereby, the thermally induced stresses in the wafer can be successfully reduced, which prevents cracks from forming in the layer material and reduces the deformation of the exposed structures. Area rates of 6 mm²/s are currently being achieved.

Applications

The developed process can be used in the semiconductor industry to increase the performance and miniaturization of mechanical and optical sensor units.

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2 Close-up of the laser-crystallized fields.
3 8" silicon wafer with selectively laser-crystallized fields.