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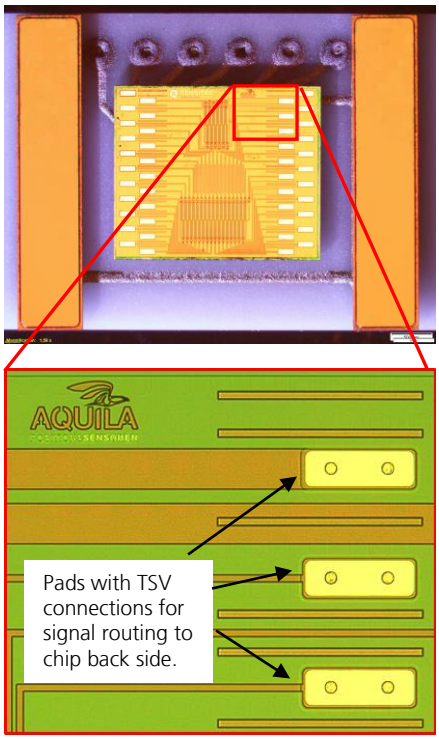

Sensor Module with 6 x 4 mm² lateral Size and TMR Sensor Chip with TSVs in Center (top), Zoom into Sensor Chip (bottom)

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High Resolution TMR Position Sensor in TSV-first Technology

Magnetic position measurement systems are regarded to be very robust and cheap compared to optical systems but do not achieve the same accuracy. The goal of the BMBF funded AQUILA project was the reduction of this accuracy gap by means of new magnetic components based on micro magnetic scale bars and TMR sensor technology. To obtain a higher measurement resolution the size reduction of both, magnetic scale elements as well as magnetic sensing elements at the sensor chip, which are facing each other in such measurement systems, was the key strategy within the AQUILA project.
However, the reduced size of the magnetic elements causes a reduced signal-to-noise ratio so that a very close distance between the sensor and the magnetic scale bar is required. Therefore it is no more possible to use classical wire bond technology to connect the sensor chip. Instead of this Through Silicon Vias (TSVs) are used to feed the signals of the sensor vertically trough the chip to its back side where it is connected to a carrier substrate.
In order to enable the new sensor chip concept an integrated fabrication process was established between Fraunhofer IZM in Berlin and Sensitec GmbH in Mainz. The fabrication flow utilizes a TSV-first approach were the TSVs are prepared as first structures into blank silicon wafers. The TSVs are etched as plugs with 20 µm diamter and 100 µm depth, isolated with silicon oxide, subsequently filled with copper and planarized to the adjacent wafer surface at the clean room facility of Fraunhofer IZM in Berlin. In subsequent processes tunnel-magentoresistive sensing elements are processed onto the wafers surface and connected with the pre-processed TSVs by Sensitec GmbH in Mainz. The remaining process fow was again executed at Fraunhofer IZM in Berlin and included the back grinding of the sensor wafers, the TSVs reveal from the wafer back side as well as signal redistribution and mico bump array formation. Finally the 100 µm thin sensor chips were assembled by thermode soldering to ceramic substrates.
The pictures show one fully assembled sensor module with the TMR sensor chip mounted with its back side on a ceramic substrate. The module has a lateral size of 4 x 6 mm² and a thickness of approx. 0,65 mm. The sensor chip itself has a lateral size of 2,2 x 2,5 mm² and features 44 IOs with TSVs. The chip hosts one incremental sensor part and one absolute sensor part and supports true power on functionality over a scale length of 25 mm with a position measurement accuracy of better than 700 nm.

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