Acoustic GHz-Microscopy, a non-destructive method for metrology in future microelectronic technologies

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The ongoing trend in microelectronics aims at increasing functionality while reducing the spatial dimensions of electronic components. Today, the approach of three-dimensional integration of individual devices with e.g. sensors and application specific circuitry into complex systems is the most promising approach. Integration in the elevation direction not only needs to address challenges in the mechanical but also of electrical interconnection of the individual devices with an increased precision. Besides several bonding techniques that incorporate the formation of vertical electrical interconnects inside the bond interface Through-Silicon-Via technology (TSV) is required for electrical connectivity in the vertical direction with direct and short path length's and the herewith corresponding electrical advantages. These novel technological concepts however, will lead to new defect risks which require new and adapted inspection methods for assessing quality-related properties and for understanding the physical relationship.

Scanning acoustic microscopy (SAM) is already widely used in quality control and failure analysis applications within microelectronics development and manufacturing. The technique is particularly sensitive to material boundaries for the assessment of quality- and reliability- affecting factors like voids and inclusions, cracks, delamination, bonding defects, and many more [1, 2]. Since 3D-integration technologies results in reduced spatial dimensions of the electrical and mechanical interconnects and, thus smaller defects, the demand on the resolution capabilities of potential inspection techniques increases. The successful application of SAM in 3D integration however, requires overcoming limitations in the achievable spatial resolution and the integration of adapted SAM analysis technologies for vertical contacts.

The current paper presents the relatively novel approach of applying acoustic microscopy in the GHz-frequency band for increasing the lateral resolution capabilities and the sensitivity to surface and near-surface features. Besides a description of the operation principle and the contrast mechanism the potential of the GHz-SAM approach will be illustrated by several case studies addressing failure analysis in microelectronics.

References  