Development of nano-focused X-ray system for wafer inspection

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Increased miniaturization of micro-electronic components is pushing the capability of the current industry inspection equipment to its limits. The achievable performance of existing equipment is rapidly becoming inadequate, with micron level resolution and 2-dimensional imaging. Conversely the new generation of Micro-Electro-Mechanical Systems (MEMS) are nanometre in scale and increasingly 3-dimensional in nature. There is thus an urgent industry need for a new inspection system capable of quality control of new MEMS devices. Defect detection during fabrication and assembly is particularly important in medical/aerospace industries where a 100% reliability rate is required to achieve the necessary safety standards. An inspection system to meet these demands is being developed as part of a European Commission Horizon 2020 collaborative project - CITCOM. This system has at its core a bespoke, standalone X-ray system for inspecting MEMS devices with sub-micron accuracy. The system includes a nano-focused X-ray source with high stability for long scans (in the order of hours) and a kV range between 10-60kV, a high accuracy manipulator capable of holding MEMS wafers up to 200mm with positional accuracy of ±2.0 µm, and a 5.5 megapixel charge-integrating X-ray detector with very fine pixel pitch. The X-ray system has the capability to inspect for internal defects within highly 3-dimensional MEMS devices and conduct high-speed metrology inspections. Initial tests of the system have been successful with all the major components integrated. Images of MEMS samples have been collected with further testing and system optimisation currently ongoing. This test programme includes a large number of sample inspections to verify the defect types that are detectable by the system, and will involve an assessment of the achievable resolution of the system via benchmarking tests with JIMA resolution test charts. Confirmation of the system's accuracy, capability and limitations will be achieved with testing within a working laboratory of a MEMS manufacturer. The functional prototype X-ray system will aim to fill the gap in the market for high resolution and detailed volumetric inspection of MEMS devices.