An interferometric test station for massive parallel inspection of passive and active M(O)EMS

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Summary

The paper presents the optical, mechanical, and electro-optical design of an interferometric inspection system for massive parallel inspection of M(O)EMS. The basic idea is to adapt an micro-optical probing wafer containing interferometer arrays to the M(O)EMS wafer under test.

Introduction

Interferometry is a versatile tool for the testing of Micro(Opto)ElectroMechanical Systems (M(O)EMS) in micro-fabrication. Interferometry can be applied for the passive characterisation of the shape, as well as for the active characterisation of deformation and resonance frequencies of M(O)EMS structures. However, recent inspection is performed in a serial manner therefore it is time consuming and thus not suitable for testing in mass production. A way to significantly increase the throughput rate and cost efficiency of the microsystems manufacturing value chain is a parallel approach to the testing process where several or all M(O)EMS structures are tested within a single measurement cycle. In the EU-project SMARTIEHS [1] a novel inspection approach is developed. By introducing a wafer-to-wafer inspection concept the parallel testing of several dozens of M(O)EMS structures within one measurement cycle becomes possible. To obtain this an exchangeable micro-optical probing wafer with array of interferometers has to be developed and aligned with the M(O)EMS wafer under test.

Discussion

Two different probing wafer configurations are presented in the form of 5x5 arrays of low coherent (LCI) and laser interferometers (LI). An array of 5x5 smart-pixel cameras is used for detection of the interferometer signals. These cameras feature optical lock-in detection at the pixel level. The draft of the instrument configuration is shown in Fig. 1 [2]. It employes a SUSS prober – PA 200 and comprises two different

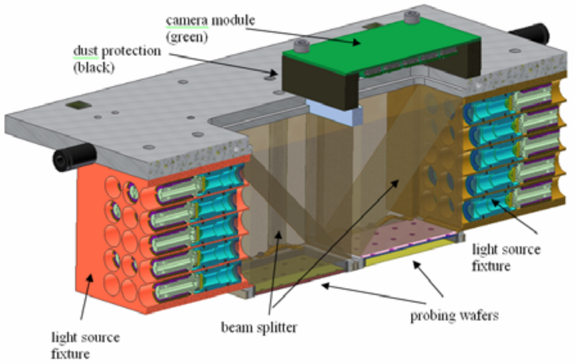

Fig 1. Optical unit of the inspection system consisting of the low coherence interferometer module (left) and the laser interferometer module right. The smart pixel camera (on top) is positioned for the laser interferometer.

interferometer arrays. Illumination, probing, imaging and excitation wafer are all exchangeable to enable the multifunctional approach. The components are modular and can be moved from one interferometer array to the other. They can thus be interchanged if the spatial distribution of the MOEMS structures or changed functionality requires this. The main functional systems are the interferometers. The LCI is the refractive optics based Mirau interferometer (Fig.2a) and it is used to measure shape and deformation of MEMS/MOEMS reflective structures with both continuous and step-like surfaces. LI is DOE based Twyman-Green interferometer (Fig.2b) and it is primarily employed for M(O)EMS vibration analysis i.e. to find the resonance frequency and spatial mode (amplitude of vibration) distribution, as well as for shape and deformation measurement of M(O)EMS with continuous surfaces.

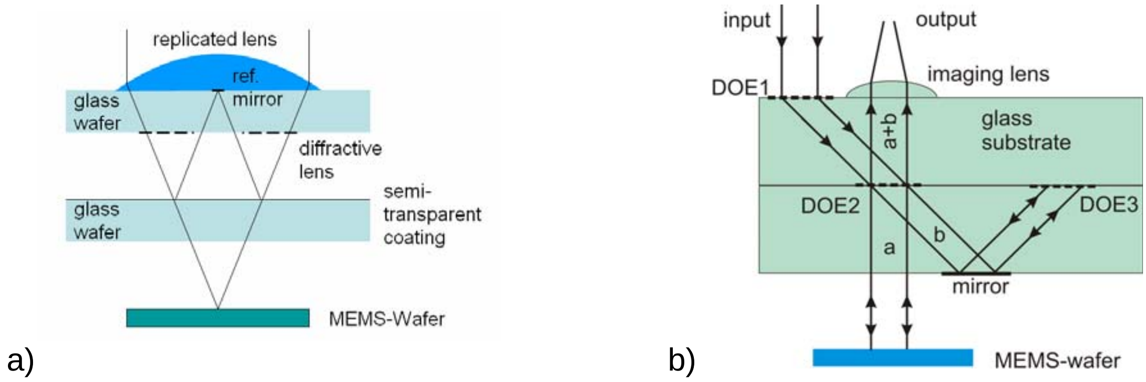

Fig 2. The scheme of a) the Mirau (refractive) low coherence interferometer and b) Twyman-Green (diffractive) laser interferometer.

The interferometers provide optical data to the camera. The developed smart-pixel architecture allows the demodulation of the electro-optical signal at the detection level. The demodulated signal from LCI is averaged over a few periods and then read out to the control system. The data volume is drastically reduced and the depth scan speed is increased without the need of a high imager read-out frame rate. The versatile electronic circuit at the pixel level not only allows amplitude demodulation but also the extraction of the modulation phase. Furthermore, conventional grey-level images can be acquired. The architecture is therefore well suited not only for LCI but also for phase-stepping LI and vibrometry.

The functionality of the single LCI and LI channel has been proven [2]. The instrument concept is based on a probing wafer inspecting 100 structures within one measurement cycle only, thus enabling in future the reduction of the measurement time by a factor of 100.The system has been developed under SMARTIEHS which is a collaborative project funded under the Grant Agreement 223935 to the 7th Framework Program Objective 2007-3.6. The authors thank all the partners for their contributions.

References

[1] www.ict-smartiehs.eu

[2]Gastinger, K., et al., Optical, mechanical and electro-optical design of an interferometric test station for massive parallel inspection of MEMS and MOEMS, Proc. SPIE 7389, 2009