Faculty of Electrical Engineering & Computer Science
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Measurement System for Vibration Measurement of Silicon Cantilever Beam.

ABSTRACT - Masterthesis

This scientific research work in the form of Thesis has been carried out to fulfil the partial requirement for an award of a Master's Degree in "Electronics Engineering" at the Hochschule Bremen Germany, Instrumentation & Measurement department.

The primary objective of this research work includes the design and development of an automated setup to measure the resonance frequency, harmonics and damping of silicon cantilever beam using software application and also for monitoring and data recording in real time. The system is based on an optical detection system combined with an automated excitation generator. The designed system is also flexible for the evaluation of different cantilevers and adequate with various frequencies.

The research work includes the division of following tasks:

- Measurement of cantilever parameters such as length, width, and thickness using measuring microscope Nikon MM-40.
- To find the natural frequency of silicon cantilever beam and mode shape of cantilever beam vibration using MATLAB.
- Fabrication of silicon cantilever from pre-processed wafer.
- Overview and selection of different excitation methods for silicon cantilever beam.
- Overview and selection of various detection methods to measure the deflection/vibration from silicon cantilever beam.
- To design experimental setup for automatic vibration of silicon cantilever beam.
- Interfacing the experimental setup with LabVIEW.
- To develop an automated data recording and analysing system in LabVIEW.
- Comparison between theoretical resonance frequency and experimental resonance frequency of cantilever parameters.

A short description of how each task is successfully carried out is explained as: First of all, literature study of various micro cantilever beams is conducted. For the fabrication of silicon cantilever beam, an anisotropic wet etching process is done from a

pre-processed wafer. Overview of different cantilever beam theory is studied for the calculation of natural frequency and mode shape. Various excitation methods such as static, dynamic, heat, photo thermal and electrostatic force methods are reviewed and selected for an automated excitation generator of silicon cantilever beam. To measure the vibration resulting from silicon cantilever beam several detections methods such as triangulation, optical lever, an acceleration measurement, piezo-resistive, piezoelectric, capacitive and optical beam deflection methods are overviewed and selected.

An experimental setup is designed for an automatic vibration of silicon cantilever beam, and its interfacing is done with LabVIEW. Finally, a comparison is made between the theoretical calculated natural frequency and the actual resonance frequency of silicon cantilever beam.