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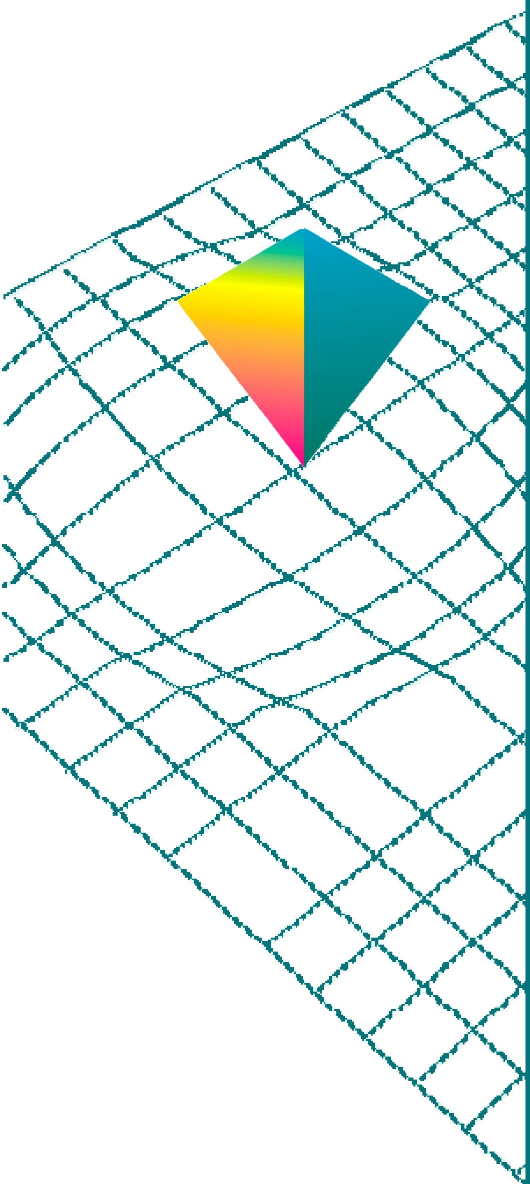

50. Internationales Wissenschaftliches Kolloquium

September, 19-23, 2005

Maschinenbau von Makro bis Nano / Mechanical Engineering from Macro to Nano

Proceedings

Fakultät für Maschinenbau /
Faculty of Mechanical Engineering

Startseite / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=15745

Impressum

Herausgeber:	Der Rektor der Technischen Universität Ilmenau Univ.-Prof. Dr. rer. nat. habil. Peter Scharff
Redaktion:	Referat Marketing und Studentische Angelegenheiten Andrea Schneider Fakultät für Maschinenbau Univ.-Prof. Dr.-Ing. habil. Peter Kurtz, Univ.-Prof. Dipl.-Ing. Dr. med. (habil.) Hartmut Witte, Univ.-Prof. Dr.-Ing. habil. Gerhard Linß, Dr.-Ing. Beate Schlütter, Dipl.-Biol. Danja Voges, Dipl.-Ing. Jörg Mämpel, Dipl.-Ing. Susanne Töpfer, Dipl.-Ing. Silke Stauche
Redaktionsschluss: (CD-Rom-Ausgabe)	31. August 2005
Technische Realisierung: (CD-Rom-Ausgabe)	Institut für Medientechnik an der TU Ilmenau Dipl.-Ing. Christian Weigel Dipl.-Ing. Helge Drumm Dipl.-Ing. Marco Albrecht
Technische Realisierung: (Online-Ausgabe)	Universitätsbibliothek Ilmenau ilmedia Postfach 10 05 65 98684 Ilmenau
Verlag:	isle Verlag ISLE, Betriebsstätte des ISLE e.V. Werner-von-Siemens-Str. 16 98693 Ilmenau

ISBN (Druckausgabe):	3-932633-98-9	(978-3-932633-98-0)
ISBN (CD-Rom-Ausgabe):	3-932633-99-7	(978-3-932633-99-7)

Startseite / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=15745

50. Internationales Wissenschaftliches Kolloquium
Technische Universität Ilmenau
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LI Yuan / FU Xing / LI Dachao / LI Mengchao / CHEN Jinping / GUO Tong / HU Xiaotang

The Dynamic Test of Cantilever Arrays Using Laser Doppler Principle on Platform of NMM

ABSTRACT

In order to evaluate the MEMS devices' dynamic mechanical properties, laser Doppler method is introduced. Combined with NMM, Polytec vibrometer is used to construct a dynamic measuring system with a large range and high precision. The resonant frequency and vibrating amplitude of a cantilever is measured. The experimental results are dicussed.

1. INTRODUCTION

In the fabrication of certain MEMS devices, such as cantilever arrays and micro-mirror arrays, there is an urgent demand to evaluate MEMS devices' dynamic mechanical properties[1]. Because laser Doppler method can only perform single-point measurement in a small area, not the whole surface information, its application in the dynamic test of devices is limited seriously. In order to extend measurement area of laser Doppler method, the NMM (Nano Measuring Machine) with a large range and high precision is introduced in the field of dynamic test and evaluation of the cantilever.

2. EXPERIMENT SETUP AND METHOD

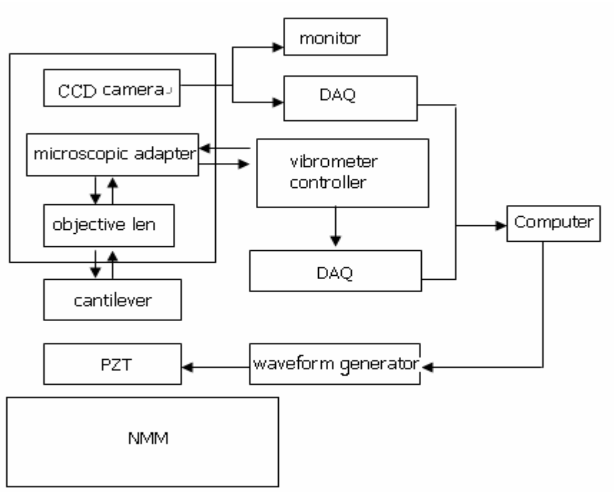

Fig. 1 Structure of the measuring system

Compared with the traditional positioning methods, such as PZT and stepping motor, the NMM improves the precision and scanning range. Meanwhile, the NMM minimizes the influence of scanner's characteristics[2]. Adaptive error compensation in the full range of motion is achieved by close-loop operation with five degrees of freedom. The high accuracy is obtained by a zero Abbe offset arrangement with three plane mirror miniature interferometers, two angular sensors and environmental sensors. The structure of the measuring system is shown in Fig.1. The stimulating signal from an arbitrary waveform generator is exerted on a PZT film, and then the mechanical vibration is transmitted to the cantilever. The laser beam is focused by a microscopy to reduce the diameter of light spot, and reflected by the cantilever with vibrating information. Through the precise movement of NMM sample stage with 0.1nm resolution, the multi-point scanning measurement is performed. This optical signal is converted into the electronic signal and gathered by a data acquisition card. The data process is achieved by the control software.

3. RESULTS AND DICUSSIONS

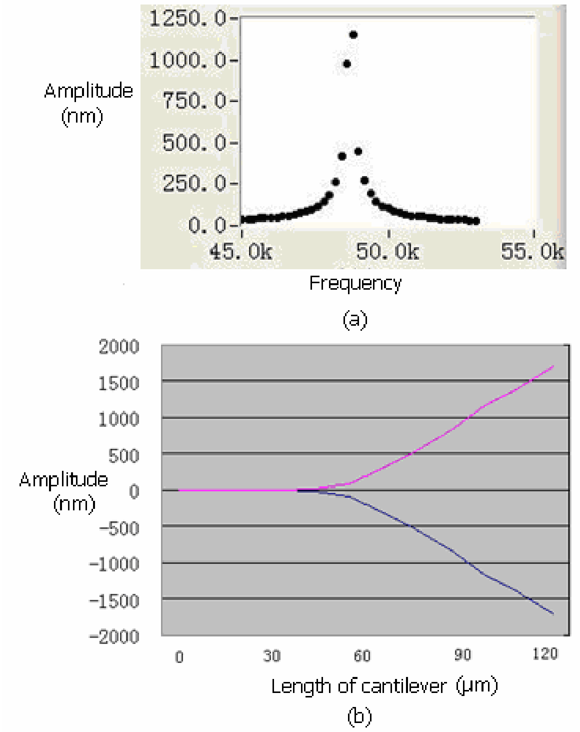

Fig. 2 (a) Resonant frequency of the cantilever
(b)Vibrating amplitude of the cantilever

Integrating with NMM, the laser Doppler measuring system can perform the multi-point test on the cantilever. The scanning range of laser Doppler system is expanded to 25mm × 25mm × 5mm. The maximum value of velocity and displacement measurement is 10m/s and 50μm respectively. The diameter of light spot depends on the magnification of the microscope objective. The minimum value is 1.25μm with 40× magnification. The highest frequency measured is 20MHz with 0.01nm resolution.

In our experiment, a cantilever with the dimension of 125μm × 55μm × 4μm is measured. The resonant frequency is about 48.8kHz, and at the end of the cantilever, the vibrating amplitude has the maximum value 1699.6nm, as shown in Fig 2(a) and (b).

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Authors:

Doctor student, Yuan LI
Tianjin Univeristy, Weijin Road No.92, Nankai District
300072, Tianjin, P. R. China
Phone: +86-22-27402444
Fax: +86-22-27406941
E-mail: cebcuk@163.com