Solid State Phenomena *Online: 2006-06-15*
ISSN: 1662-9779, Vol. 113, pp 73-78
doi:10.4028/www.scientific.net/SSP.113.73

Hybrid Experimental – Numerical Full-Field Displacement Evaluation for Characterization of Micro-Scale Components of Mechatronic Systems

Vytautas Ostasevicius[1,a], Norm Gitis[2,b], Arvydas Palevicius[1,c], Minvydas Ragulskis[4,d] and Sigitas Tamulevicius[5,e]

[1]International Studies Center, Kaunas University of Technology, A. Mickeviciaus 37, LT-44245, Kaunas, Lithuania

[2]Center for Tribology, Inc., 1715 Dell Avenue, Campbell, CA 95008, USA

[3]Department of Mathematical Research in Systems, Kaunas University of Technology, Studentu 50-222, LT-51368, Kaunas, Lithuania

[4]Institute of Physical Electronics, Kaunas University of Technology, Savanoriu 271, LT-50131, Kaunas, Lithuania

[a]vytautas.ostasevicius@ktu.lt, [b]ngitis@cetr.com, [c]arvydas.palevicius@ktu.lt, [d]minvydas.ragulskis@ktu.lt, [e]sigitas.tamulevicius@ktu.lt

Keywords: mechatronics, holography, visualization, micro-electromechanical systems

Abstract. Hybrid experimental – numerical techniques are applied to the problem of the interpretation of patterns of fringes that are generated by non-contact full-field experimental methods applied for analysis of dynamic displacement fields of MEMS components. It is shown that even rather simple cantilever beam of a MEMS switch can exhibit complex dynamical response due to the nonlinearities of interactions and the surrounding noise. In many instances the interpretation of experimental results is possible only after numerical simulation of MEMS components in virtual computational environments.

Introduction

In recent years, the field of mechatronic systems has quickly developed from pure research into wide spread industrial applications [1]. In addition to the commercialization of some less-integrated mechatronic devices, such as micro-accelerometers, inkjet printers heads, micro-mirrors for projection, etc. the concepts and feasibility of more complex mechatronic systems have been proposed and demonstrated for applications in such varied fields as microfluidics, aerospace, biomedicine, chemical analysis, wireless communications, data storage, display optics etc. [2]. Some branches of mechatronics, such as micro-opto-electromechanical systems (MOEMS), micro total analysis systems etc. have attracted a great deal of research interest due to their potential market [3]. It is used to fabricate such features as clamped beams, membranes, cantilevers, grooves, etc. Also, it is important to keep in mind that homogeneity, commonly used with accuracy for bulk materials, becomes unreliable for modeling devices that have dimensions comparable to the material intrinsic lengths (grain size, microscopic fluctuations, interaction distances, etc.). Recent interest in applying mechatronics technology to the miniaturization of relays for a variety of applications requires the design of appropriate testing and measurement tools for investigation of dynamic properties of those systems.
Technological aspects of mechatronic systems design and methods of their characterization are overviewed in this paper. As a typical example, a microelectromechanical switch [4, 5] containing specular metallic surface was fabricated using a surface micromachining technique and employing UV-exposure of a special thick resist for the nickel electroplating. Application of different measurement technologies capable of detecting the dynamic properties of micro-scale mechatronic systems to understand and evaluate the functionality of the components is also presented.