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Abstract

Author names and affiliations

Publication timeline

Micro and Macro Deformation of Single Crystal NiTi

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We present experimental results on the incremental Vickers micro-indentation and compres- sion of polycrystalline (001) [251] single crystals. The tests are conducted at room temperature where the solvus of A1 at 18 degrees above A, and the solvus of T-T at 18 degrees above A, show distinct feature, it is discovered that displacement motion and a reversable stress-induced martensitic transformation influence the micro-indentation response of T-T at 18 degrees above A, while the micro-indentation of T-T at 18 degrees above A, only induces irreversable displacement motion. The effect of the surface normal orientation on material hardness was negligible in the T-T at 18 degrees above A, and followed trends anticipated by the activation of favorable slip systems in the T-T at 18 degrees above A. Compression tests on the identical T-T at 18 degrees above A samples revealed deformation by coupled stress-induced martensitic and plastic flow, depending on the crystallographic orientation. The trends in hardness with surface normal orientation were not commensurate with the orientation dependence of the material's compressive transformation or "yield" strength. The ramifications of the tests in terms of comparing micro-indentation and micro-compression and the interactions between plasticity and the stress-induced martensitic transformation are discussed.

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Critical Review: Adhesion in surface micromechanical structures

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(Received 15 November 1996; accepted 15 November 1996)

We present a review on the state of knowledge of surface phenomena behind adhesion in surface micromechanical structures. After introducing the problems of release-related and in-use adhesive, a theoretical framework for understanding the various surface forces that cause strong adhesion of micromechanical structures is presented. Various approaches are described for reducing the work of adhesion. These include surface roughening and chemical modification of polycrystalline silicon surfaces. The constraints that fabrication processes such as release, drying, assembly, and packaging place on surface treatments are described in general. Finally, we briefly outline some of the important scientific and technological issues in adhesion and friction phenomena in micromechanical structures that remain to be clarified.

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Critical Review: Adhesion in surface micromechanical structures

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We present a review of the state of knowledge of surface phenomena behind adhesion in surface micromechanical structures. After introducing the problem of release-related and in-situ adhesion, a theoretical framework for understanding the various surface forces that cause strong adhesion of micromechanical structures is presented. Various approaches are described for reducing the work of adhesion. These include surface roughening and chemical modification of polyethylene terephthalate surfaces. The constraints that fabrication processes such as release, drying, assembly, and packaging place on surface treatments are described in general. Finally, we briefly outline some of the important scientific and technological issues in adhesion and friction phenomena in micromechanical structures that remains to be elucidated.

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1. INTRODUCTION

Surface micromachining is defined as the fabrication of micromechanical structures from deposited thin films. Although the basic ideas date back to the 1960s, it has been the focus of rapidly growing research and, recently, commercial applications. Surface micromachining is one of the core technologies underlying microelectromechanical systems (MEMS), which promises to extend the benefits of microelectronic fabrication technology to sensing and actuating.

Another reason is the potential of monolithic integration, which incorporates surface micromachining into an integrated electronic format. Early applications of this technology include the silicon micromachined accelerometer, which has been the order of 10× smaller than its silicon counterpart manufactured on a complementary metal-oxide-semiconductor (CMOS) static random access memory (SRAM) integrated circuit. Integrated accelerometers for digital display and, more recently, for microelectronics, have been demonstrated in micromachined silicon. The suspension of the sensor from the substrate is achieved by micromachining techniques. This allows for the fabrication of a structure that is sufficiently small to fit on a single silicon chip. Recently, a modular process that embeds the polysilicon microstructure in the wafer prior to CMOS fabrication was developed.

Surface micromachined structures typically range from 0.1 to several microns in thicknesses with lateral dimensions up to 1 cm and thicknesses from 1 to 10 μm. A representative polysilicon-based integrated microsystem device is shown in Fig. 1. The structure consists of a silicon substrate with etched cavities that are interconnected by a 3D interconnect network. The structure is made using a combination of CMOS and micromachining processes. The silicon substrate provides the mechanical and thermal support for the microsystem. The silicon substrate is typically 200 μm thick with a silicon dioxide layer on the surface. The silicon dioxide layer provides a means to attach the MEMS device to the chip. The silicon substrate also provides the electrical connections to the MEMS device. The silicon substrate is then encased in a package to provide protection and isolation from the environment. The package is typically made of plastic or metal and is then encapsulated to provide electrical and thermal isolation.

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Micro and Macro Deformation of Single Crystal NiTi

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1 Introduction

Traditional applications of NiTi shape memory alloys include operation of various devices such as valves, pumps, surgical clamps, and orthopedic devices [1]. The scientific applications explore the ability of NiTi shape memory alloys to recover initial states while on the order of 0.5% by heating shape memory or strain memory (quasimemory). Currently, understanding the thermo-mechanical behavior of NiTi shape memory alloys is critical in designing systems that can be actuated via the NiTi material's shape memory effect.

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Critical Review: Adhesion in surface micromechanical structures

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We present a review of the state of knowledge of surface phenomena behind adhesion in surface micromechanical structures. After introducing the problems related to fabrication and micromechanical adhesion, a theoretical framework for understanding the various surface forces that cause strong adhesion of micromechanical structures is presented. Various approaches are described for reducing the work of adhesion. These include surface roughening and modification, dielectric and electrostatic forces on surfaces. The constraints that fabrication processes such as release, drying, assembly, and packaging place on surface treatments are described in general. Finally, we briefly outline some of the important device and technological issues in adhesion and friction phenomena in micromechanical structures that remain to be addressed.

Keywords: Surface adhesion, Surface micromechanical structures, Adhesion energy, Surface roughness, Electrostatic forces

I. INTRODUCTION

Surface micromachining is defined as the fabrication of micromechanical structures from deposited thin films. Although the basic ideas date back to the 1960s, it has been the focus of growing research and recently, commercial applications. Surface micromachining is one of the core technologies underlying microelectromechanical systems (MEMS), which promises to extend the benefits of microelectronic fabrication technology to sensing and actuating functions. One of the reasons that micromachining has rapidly gained the interest is the availability of thin-film deposition techniques that are easy to scale and suitable for the surface micromachining process. These techniques can be divided into two categories: single-crystal silicon (SCS) and polycrystalline silicon (PSI). The first category includes techniques such as chemical vapor deposition (CVD), physical vapor deposition (PVD), and electron-beam deposition (EBD). The second category includes techniques such as sputtering, ion beam-assisted deposition (IBAD), and ion beam deposition (IBD). The choice of deposition technique depends on the specific requirements of the micromachining process and the properties of the deposited material.
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• You may develop a preferred style
  – Read the abstract and conclusions first
  – Look at all the figures before reading the text
  – Focus on a particular aspect (like the experimental techniques for instance)

• Read it more than once

• Find some of the references cited and read those too
How do I read a journal article?

• Not all articles are perfect (and some aren’t even close). Why not?
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  – Incomplete understanding
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