PROCEEDINGS

53. IWK

Internationales Wissenschaftliches Kolloquium
International Scientific Colloquium

Faculty of
Mechanical Engineering

PROSPECTS IN MECHANICAL ENGINEERING

8 - 12 September 2008

www.tu-ilmenau.de

TECHNISCHE UNIVERSITÄT
ILMENAU

Published by
Impressum

Publisher Herausgeber	Der Rektor der Technischen Universität Ilmenau Univ.-Prof. Dr. rer. nat. habil. Dr. h. c. Prof. h. c. Peter Scharff
Editor Redaktion	Referat Marketing und Studentische Angelegenheiten Andrea Schneider
	Fakultät für Maschinenbau Univ.-Prof. Dr.-Ing. habil. Peter Kurz, Univ.-Prof. Dr.-Ing. habil. Rainer Grünwald, Univ.-Prof. Dr.-Ing. habil. Prof. h. c. Dr. h. c. mult. Gerd Jäger, Dr.-Ing Beate Schlütter, Dipl.-Ing. Silke Stauche
Editorial Deadline Redaktionsschluss	17. August 2008
Publishing House Verlag	Verlag ISLE, Betriebsstätte des ISLE e.V. Werner-von-Siemens-Str. 16, 98693 Ilmenau

CD-ROM-Version:

Implementation Realisierung	Technische Universität Ilmenau Christian Weigel, Helge Drumm
Production Herstellung	CDA Datenträger Albrechts GmbH, 98529 Suhl/Albrechts

ISBN: 978-3-938843-40-6 (CD-ROM-Version)

Online-Version:

Implementation Realisierung	Universitätsbibliothek Ilmenau ilmedia Postfach 10 05 65 98684 Ilmenau

Home / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=17534

T. Friedrich / C. Raudzis / R. Müller-Fiedler

Characterization of anti stiction coatings by adhesion force measurement

Introduction

In microelectromechanical systems (MEMS) unintentional adhesion, known as stiction, is a major failure mechanism. A common way to overcome stiction is to coat the surface of the MEMS devices with low surface energy materials. To evaluate these anti stiction coatings the adhesion force, which is required to separate two contacting surfaces, was measured by micro devices in dependence of the coating, the contact geometry, the contact force, the temperature and the number of contacts.

Micro devices for adhesion force measurement

There are different micro devices for the in-plane (IP) and out-of-plane (OP) adhesion force measurement (Fig. 1). The IP test structure, based on an approach of Timpe et al., is composed of two moveable shuttles with comb drives for actuation [1]. The OP test structure consists of a seesaw structure with comb drives on both sides and can be tilt by levitation forces [2]. Both test structures are used in a similar way. The actuation is done electrostatically by applying a voltage V to the comb drives and the resulting deflection is simultaneously recorded by a capacitive measurement. Once the test structures are in contact at the contact voltage V_{con} the deflection keeps constant and a defined contact force can be applied by further increasing V. To release the structures V is decreased. After passing V_{con} the adhesion force F_{ad} inhibits the separation of the structures. By further decreasing of V the structures will separate again which determines the release voltage V_{rel}. Hence, F_{ad} is calculated by the known electrostatic forces at contact and release defined by the comb drive geometry and the contact and release voltages.

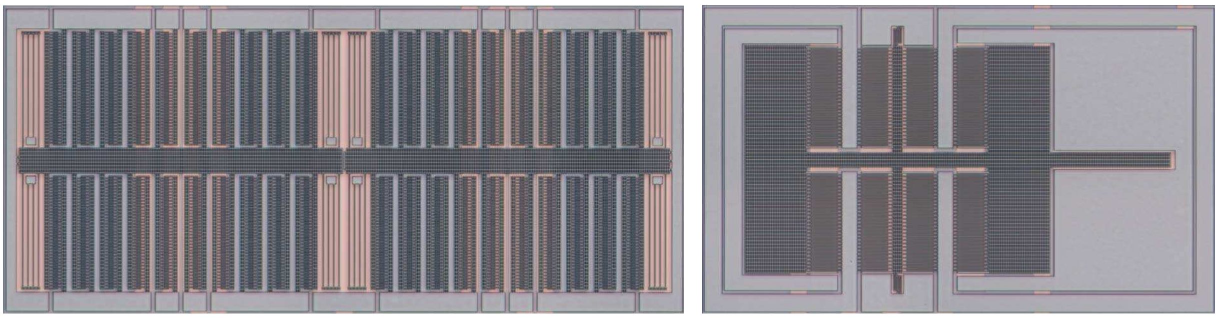

Fig.1 Optical images of the test structures for in-plane (left) and out-of-plane (right) contact

Experimental results (see DVD for all results)

All experiments are carried out on wafer level with encapsulated test structures and within an inert neon atmosphere or in vacuum. In order to compare in-plane and out-of plane adhesion forces both test structures are fabricated on the same wafer to ensure an identical surface chemistry. To vary the surface chemistry several wafers with different coatings are available. The contact geometry varies inevitably within a wafer due to inhomogeneous fabrication processes and is also modified by different layouts of the contact area including flat and sharp formed areas. Furthermore environmental and contact conditions such as the temperature and the contact force are modified. There is also a dependence of the adhesion force on the number of contacts and the previous contact conditions. Therefore all measurements are evaluated with respect to there history of contacts. An example of the dependence of the IP adhesion force on several influences is shown in figure 2. Please see the DVD for all results and discussion.

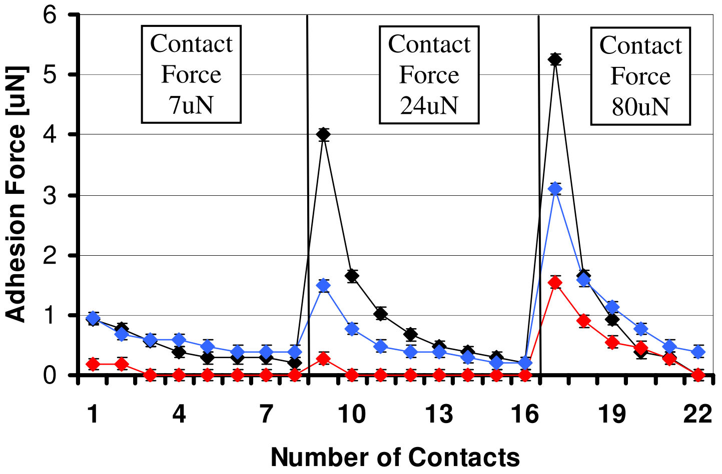

Fig.2 Dependence of the IP adhesion force on uncoated (black, blue) and coated (red) surfaces, small (black, red) and big (blue) contact areas, the contact force and the number of contacts

Conclusion

A direct comparison between in-plane and out-of-plane adhesion forces is enabled due the novel out-of-plane test structure. The combined influence of the coating, the contact area, the contact force and the number of contacts on the adhesion force is evaluated.

References:

[1] S.J. Timpe, K. Komvopoulos, “An Experimental Study of Sidewall Adhesion in Microelectromechanical Systems”,
Journal of microelectromechanical systems, Vol. 14, No. 6, pp. 1356-1363, 2005

[2] W.C. Tang, M.G. Lim, R.T. Howe, „Electrostatic Comb Drive Levitation and Control Method“,
Journal of microelectromechanical systems, Vol. 1, No. 4, pp. 170-178, 1992

Authors:
Dipl.-Ing. Thomas Friedrich
Dr. rer. nat. Carsten Raudzis
Dr. rer. nat. Roland Müller-Fiedler
Robert Bosch GmbH, Robert-Bosch-Platz 1
70839 Gerlingen-Schillerhöhe
Phone: +49 711 811-6380
E-mail: thomas.friedrich2@de.bosch.com