6th European Conference for Clinical Nanomedicine, June 23-26 2013, Basel, Switzerland.

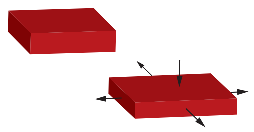
Cantilever bending for nanostructure characterization of artificial muscles

Peter Thalmann[1], Florian M. Weiss[1], Hans Deyhle[1], Tino Töpper[1], Elisa Fattorini[1,2] and Bert Müller[1*]

[1]Biomaterials Science Center, University of Basel, Switzerland

[2]Kantonspitäler Schaffhausen(KSSH), Switzerland

INTRODUCTION



Incontinence is a common devestating phenomenon in western countries with increased prevalence in elderly people, e.g, up to 30% of males at the age of 70. Furthermore, it is often accompained by social isolation due to fear of public embarassement. The presently available hydraulic artifical sphincter have severe drawbacks such as constant pressure on the tissues leading to atrophy and erosion [2]. We therefore intend to develop an artificial sphincter (AS) based on the technology of electrically acitvated polymers (EAP). Currently we are investigating the behavior of EAP-structures by using cantilever bending.

SAMPLE PREPARATION

1. Polyetheretherketone (PEEK) ~25 µm were used as a substrate.
2. Under ultra-high vacuum conditions a 50 nm-thin silver layer was deposited on the substrate.
3. Then the polydimethylsiloxane (PDMS) was distributed on the silver layer using doctor blading
4. To crosslink the PDMS films, the sample was heated at a temperature of 80 °C for 90 min.
5. In order to establish a condensator an other silver layer of 50 nm-thickness was deposited on top of the PDMS.

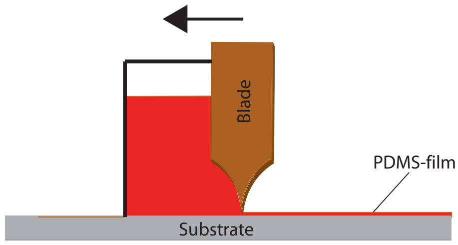
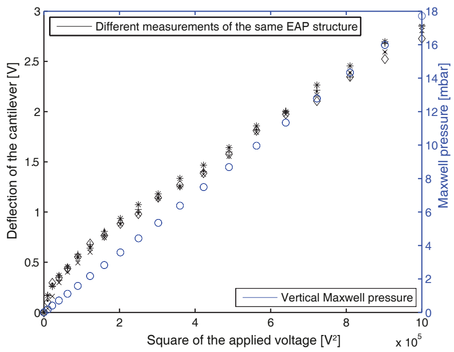


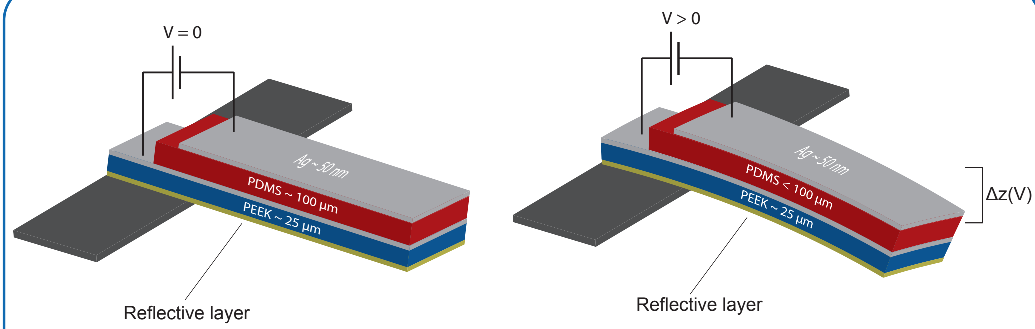
Illustration of the doctor blade method

RESULTS

First measurements revealed a linear dependence of the cantilever deflection with respect to the square of the applied voltage. However, the more interessting fact is, that for lower voltages the deflection is bigger than most simple consideration would predict [3].



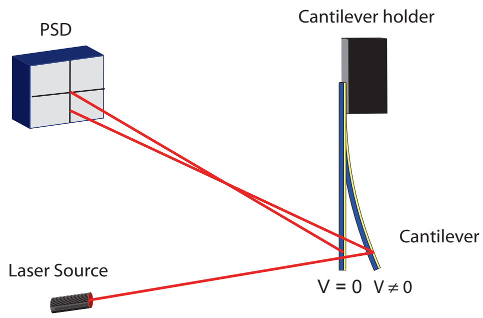
PRINCIPLE



Applying a voltage between the two metal films results in a Maxwell pressure on the EAP-structure. This pressure induces a surface stress on the PDMS-PEEK interface, which results in a bending of the sample. The dimensions of the cantilever are about 3 mm x 15 mm.

METHODS

A laser beam is pointed at the free end of the cantilever. The incoming beam is reflected at the reflective layer at the bottom of the cantilever towards a position sensitive device (PSD) with submicrometer resolution. The bending of the cantilever changes the angle of incidence. Hence, the angle of reflection is changed as well. This causes a shift of the beam spot on the PSD. Due to geometric reasons it is possible to detect deflections of the cantilever's free end in nanometer scale.



FUTURE GOALS OF INVESTIGATION

Investiagation of low-voltage behavior for PDMS-based EAP-structures of different thicknesses in the micro- and nanometer range.

=> Characterization of the EAP-structure
=> More detailed information on the resulting surface stress due to the applied voltage
=> Optimazation of the cantilever bending due to an applied voltage

CONCLUSION AND ACKNOWLEDGEMENT

So far it is not yet completely understood how the Maxwell pressure is translated into the surface stress, which causes the cantilever to bend. In order to optimize the deflection of the cantilever per voltage, which is nessecary for the realization of actuators to be incorporated into AS prototypes, the low-voltage behavior of EAP-structures needs to be further investigated. However, the cantilever beam bending method has shown its potential of being a powerful and cost-efficient approach to detect deformation of EAP micro- and nanostructures. Furthermore, the authors gratefully acknowledge the financial support of the Swiss National Science Foundation (project 200021-135496) and G. Kovacs and F. Habrard (Empa Dübendorf).

[1] F.M Weiss et al. Proc. SPIE, 8340, 83400A1-A10 (2012) [2] D.S Elliott et al. J Urol 159(4), 1206-8 (1998)
[3] F.M Weiss et al. Proc. SPIE, 8687, 86871X1-X6 (2013)

*bert.mueller@unibas.ch

spitäler schaffhausen