

Integrated MEMS force sensors in medical technologies

PhD Report – 1st semester

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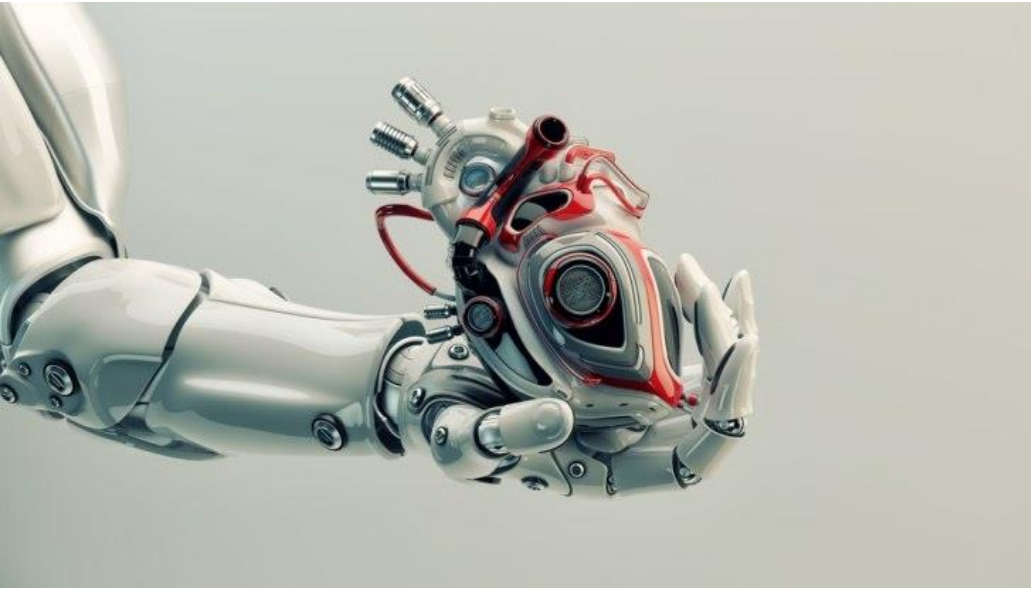
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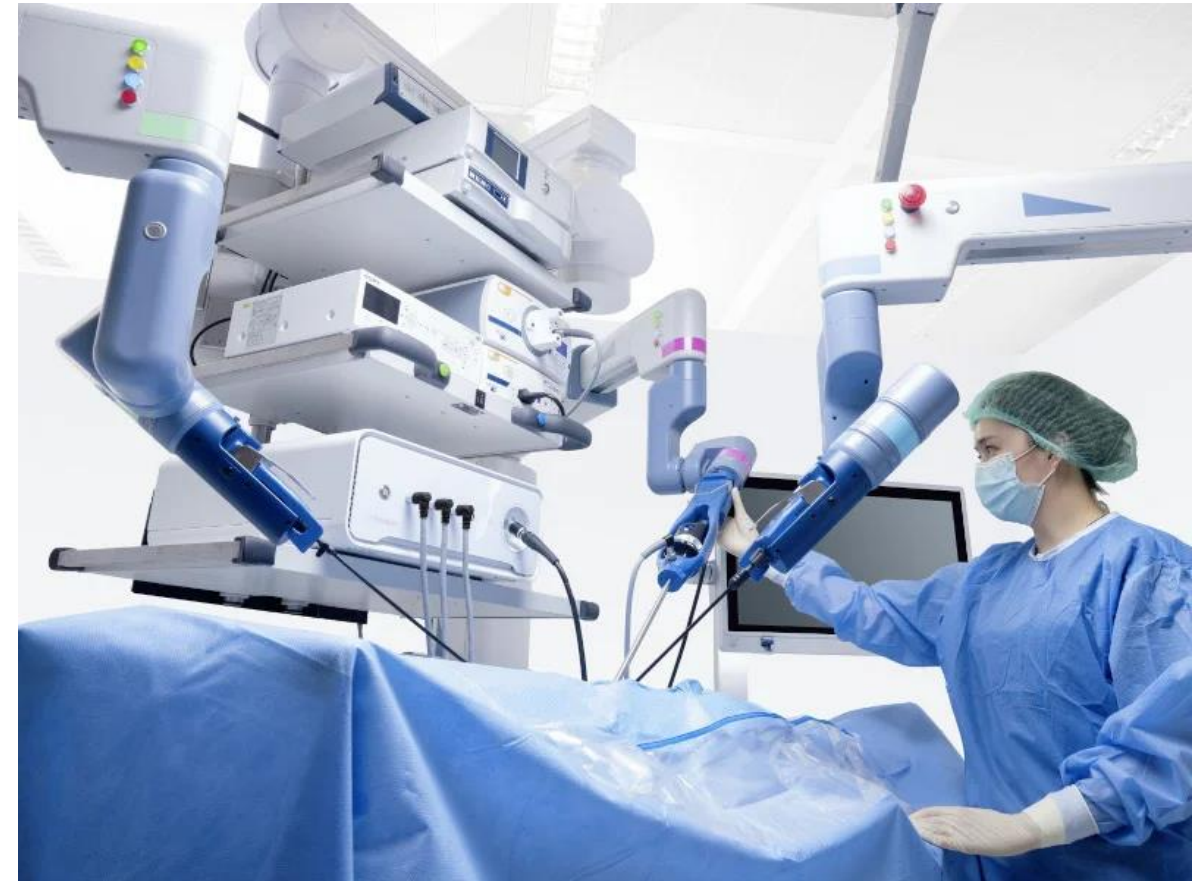
www.ek-cer.hu | www.mems.hu | www.biomems.hu



Introduction



Minimally Invasive Surgery (MIS)



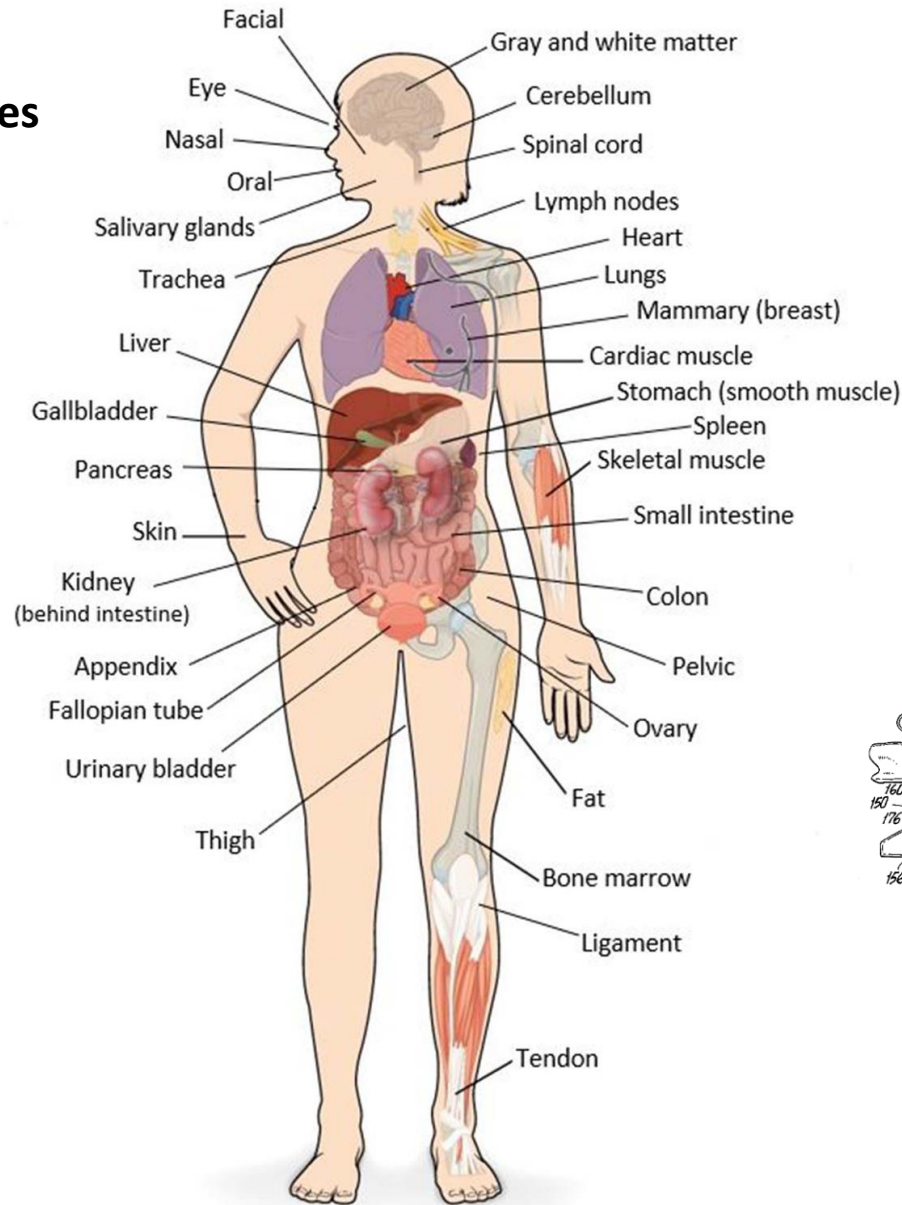
„Almost all engineers working on new designs find that they do not have all the needed information. Most often, they are limited by insufficient scientific knowledge. Thus, they study mathematics, physics, chemistry, biology and mechanics. Often, they have to add to the sciences relevant to their profession. Thus, engineering sciences are born.”

Y.C.Fung, the „father of biomechanics”

Introduction

Mechanical properties of tissues

- Qualitative
- Quantitative



In-situ measurements

- safety
- tissue recognition
- tumor vs. healthy

Supporting decisions during MIS surgery

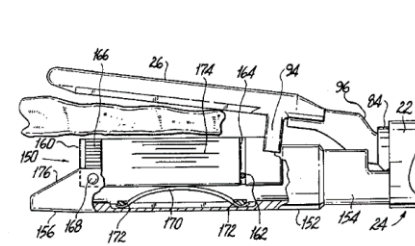
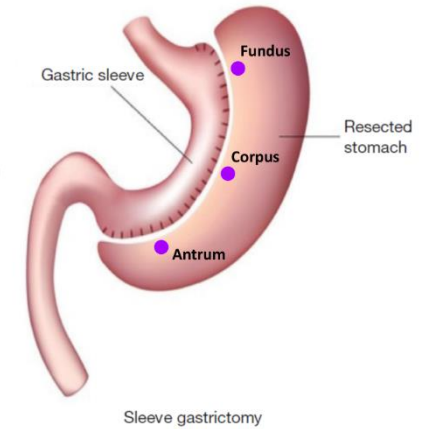
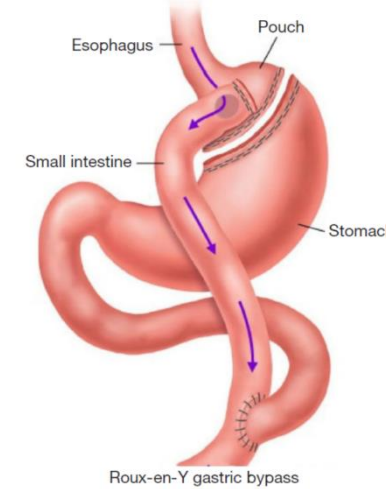
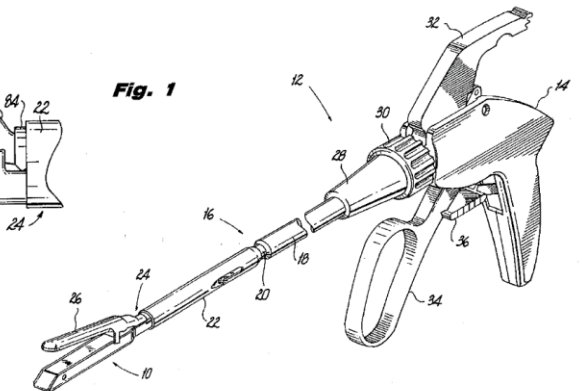
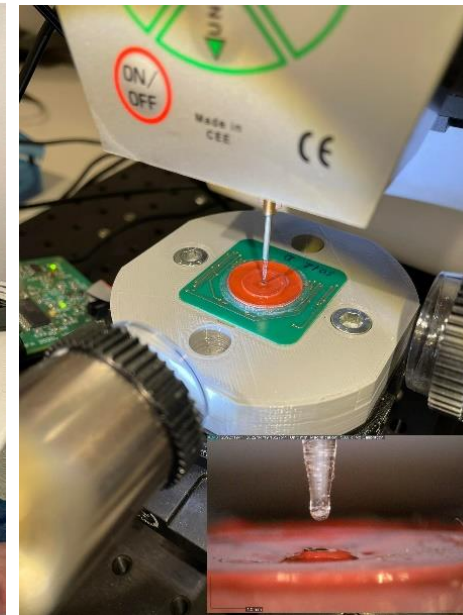
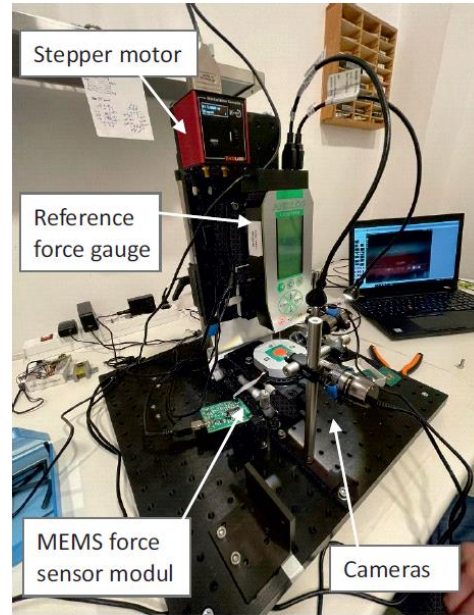
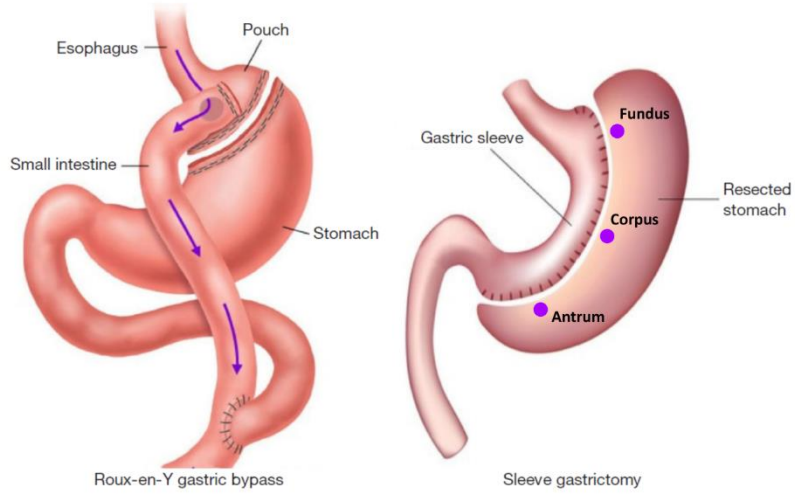


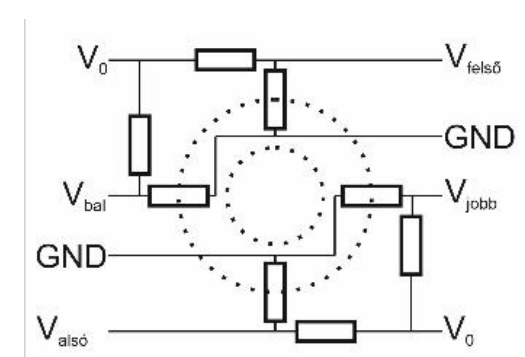
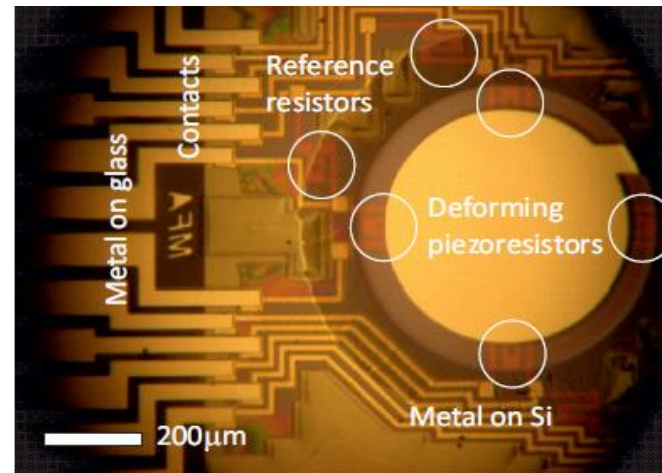
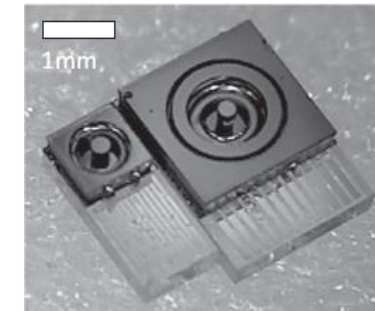
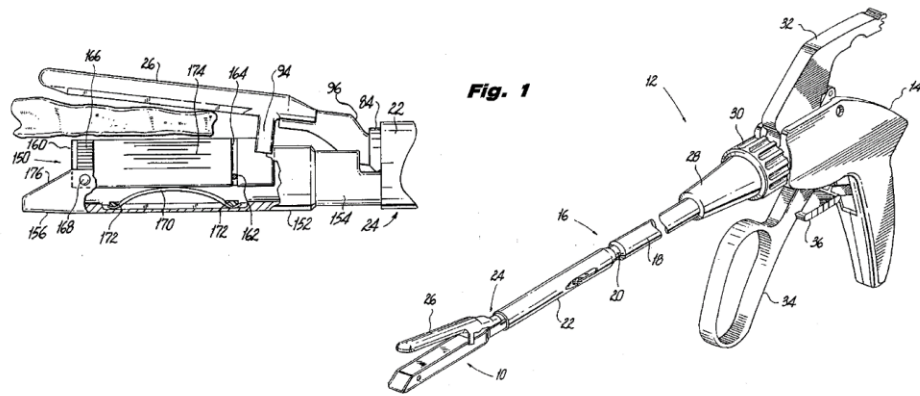
Fig. 1



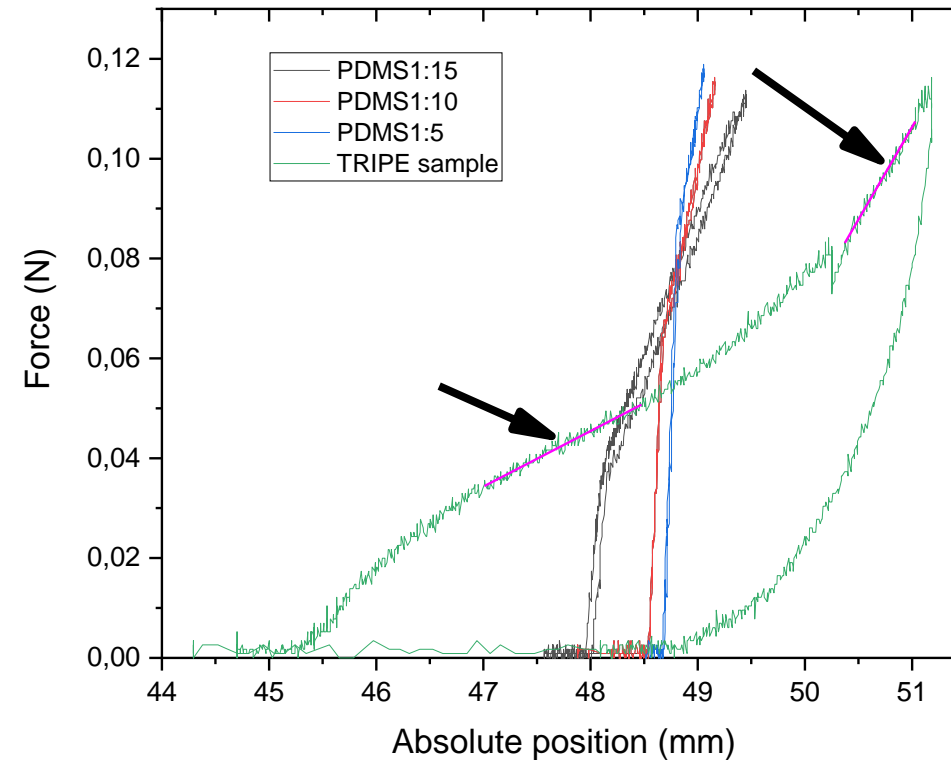
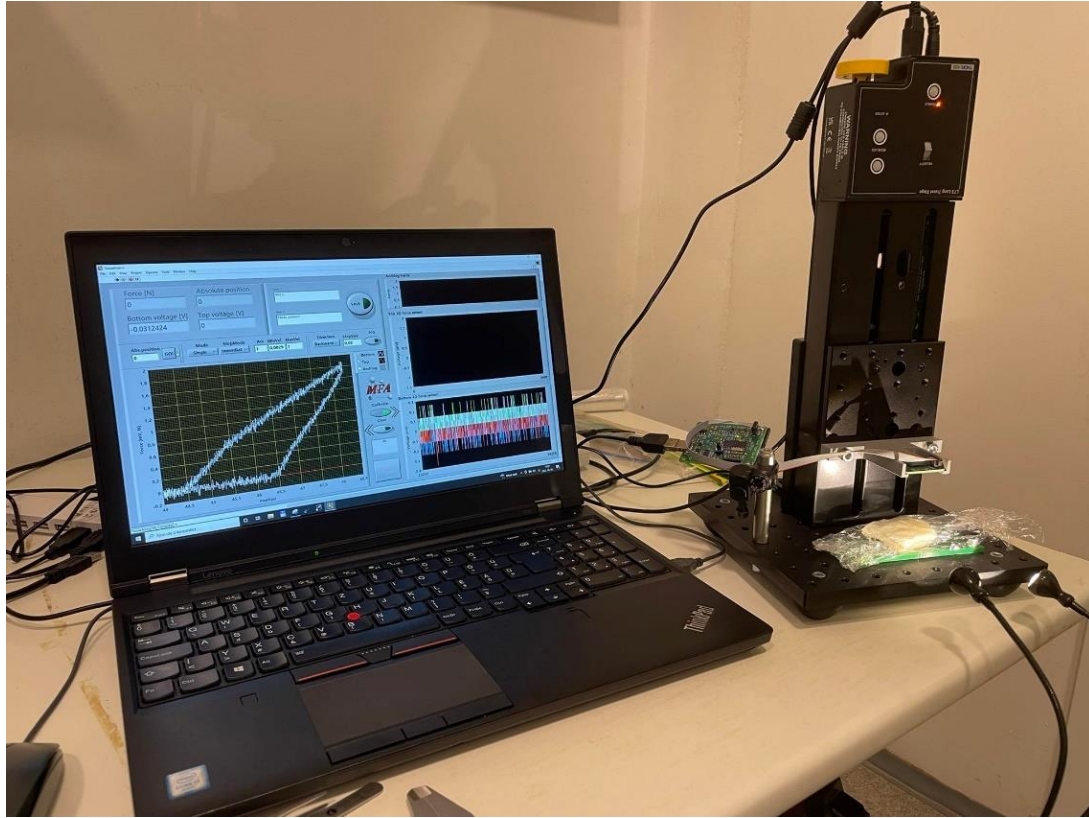
Introduction



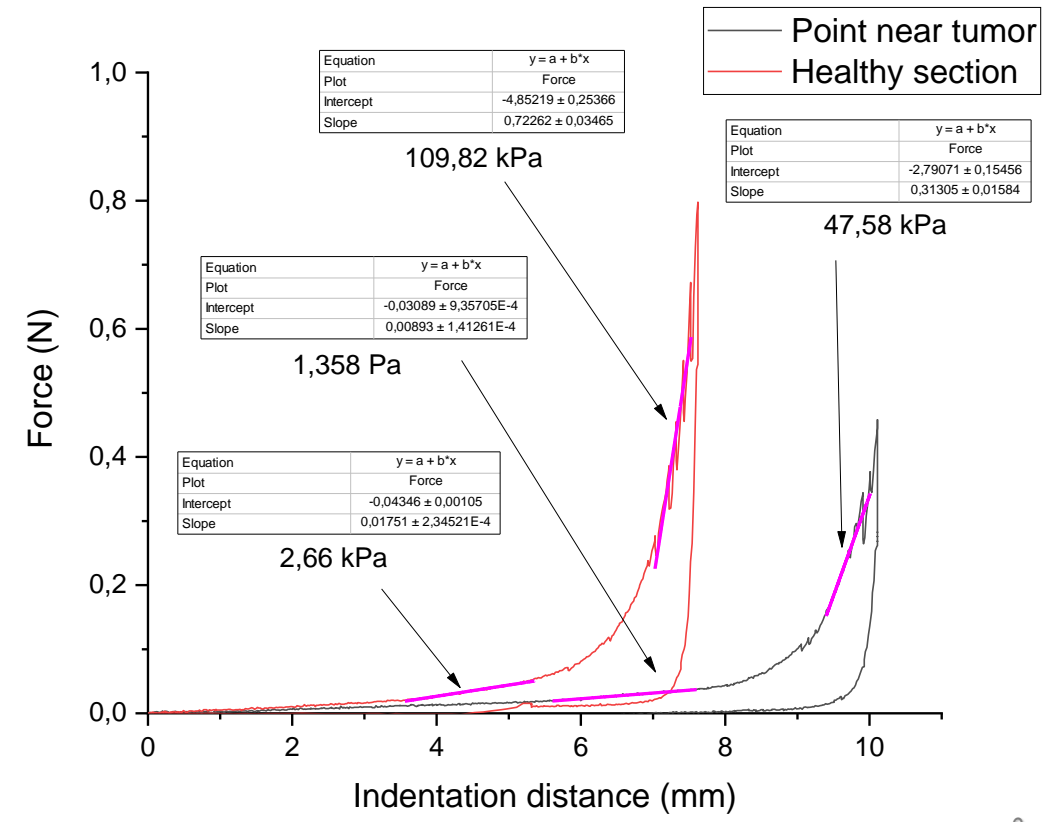
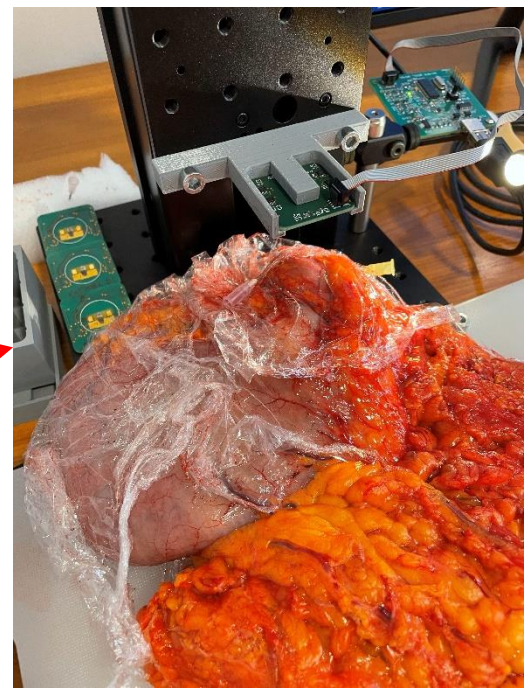
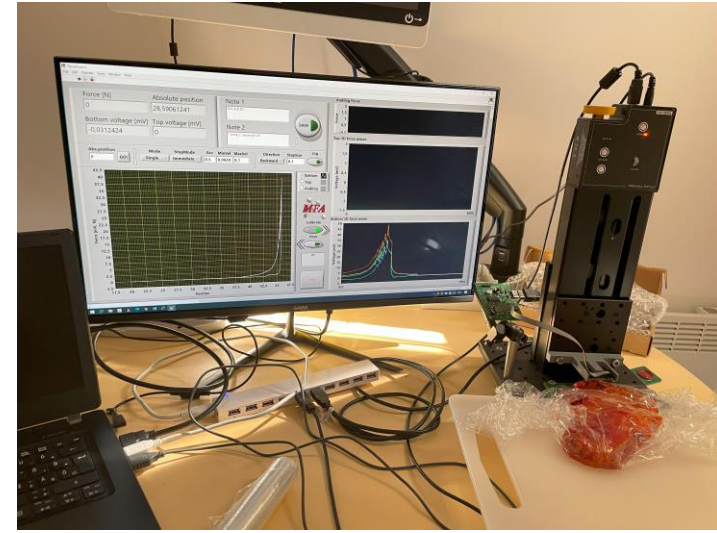
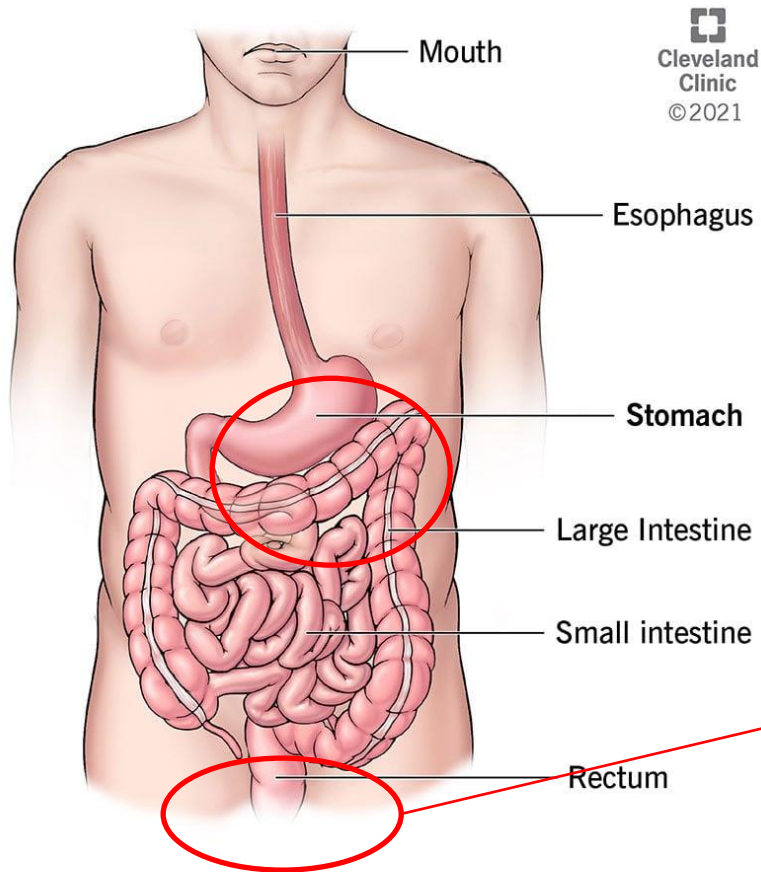
High integrability MEMS force sensors for a new generation of medical devices!



Biomechanical tissue testing

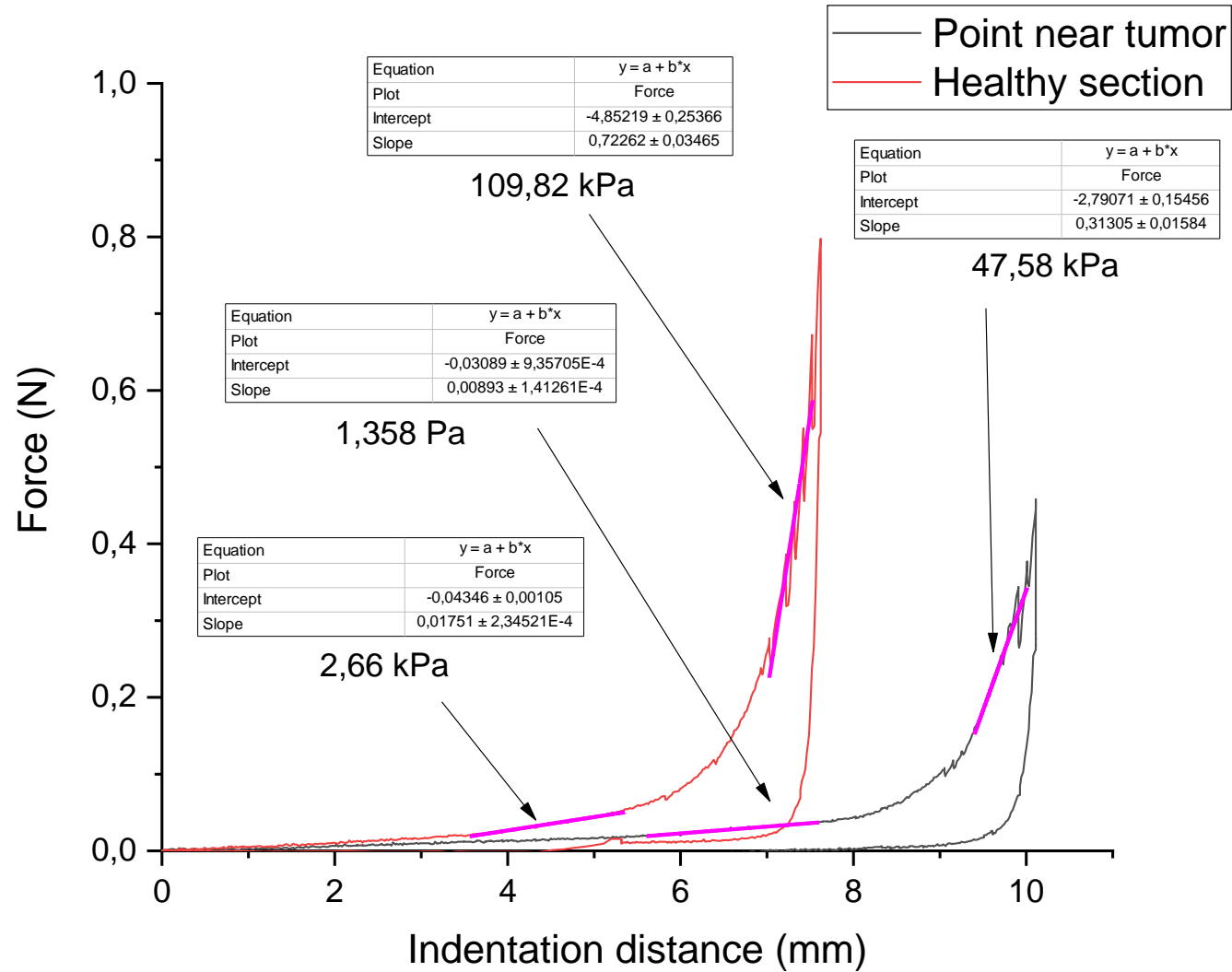


Biomechanical tissue testing

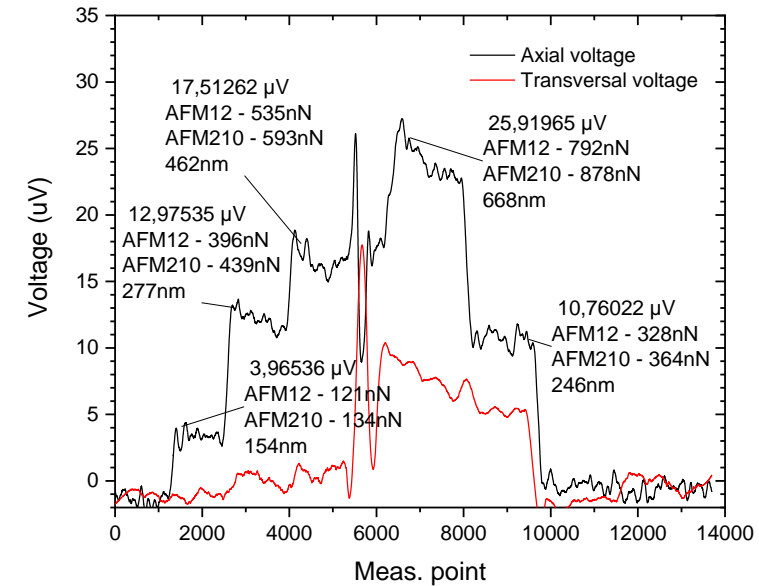
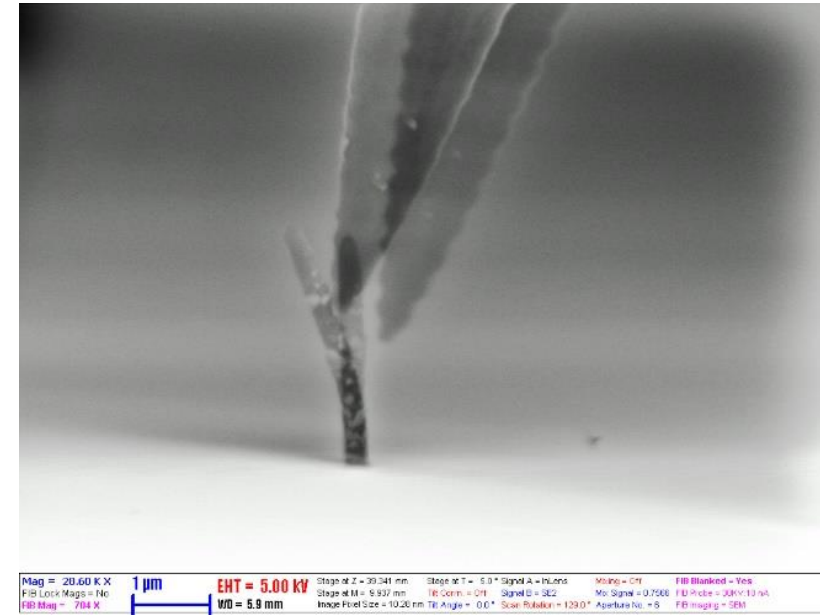
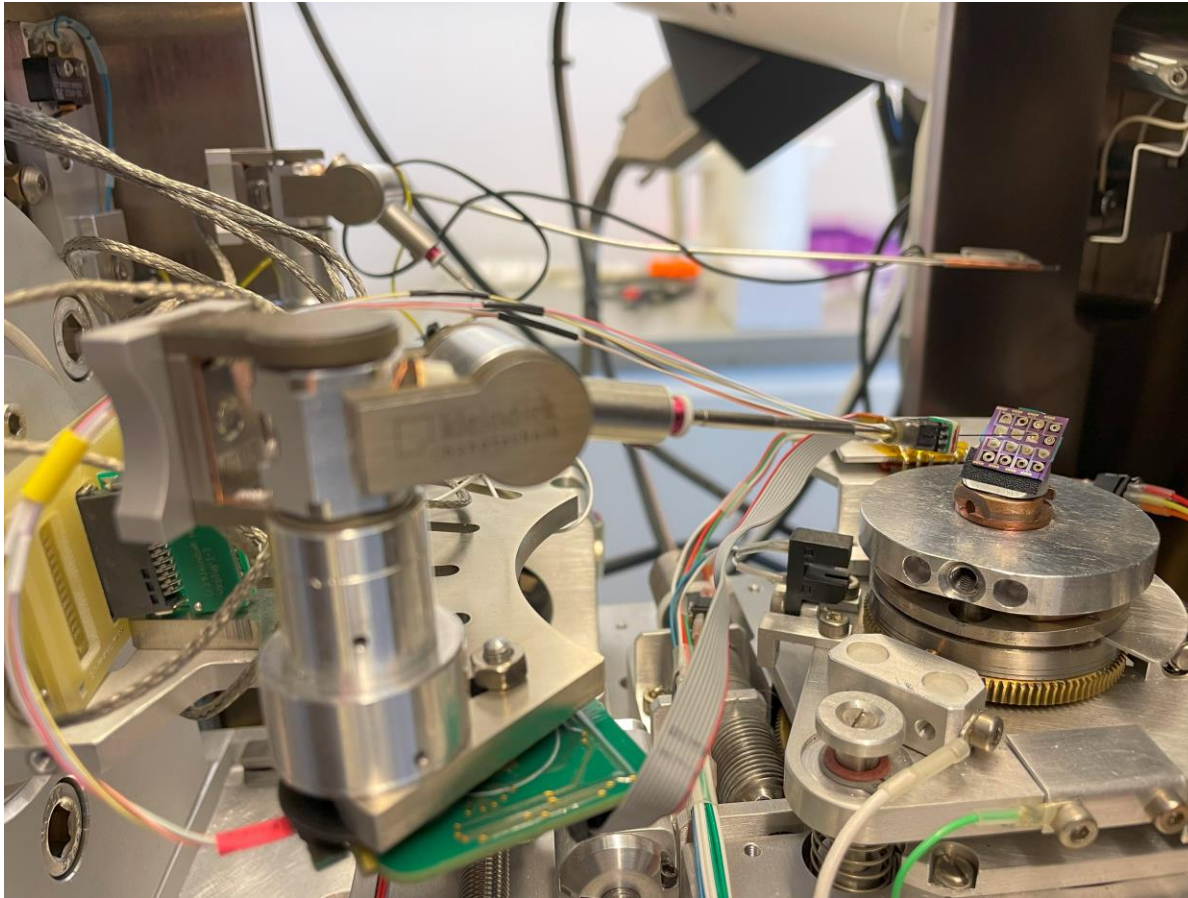


Etikai engedély ügyiratszám:
IV/174- 2 /2022/EKU

Biomechanical tissue testing



SEM nano tests

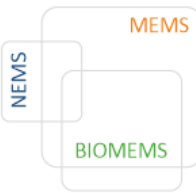


Future applications:

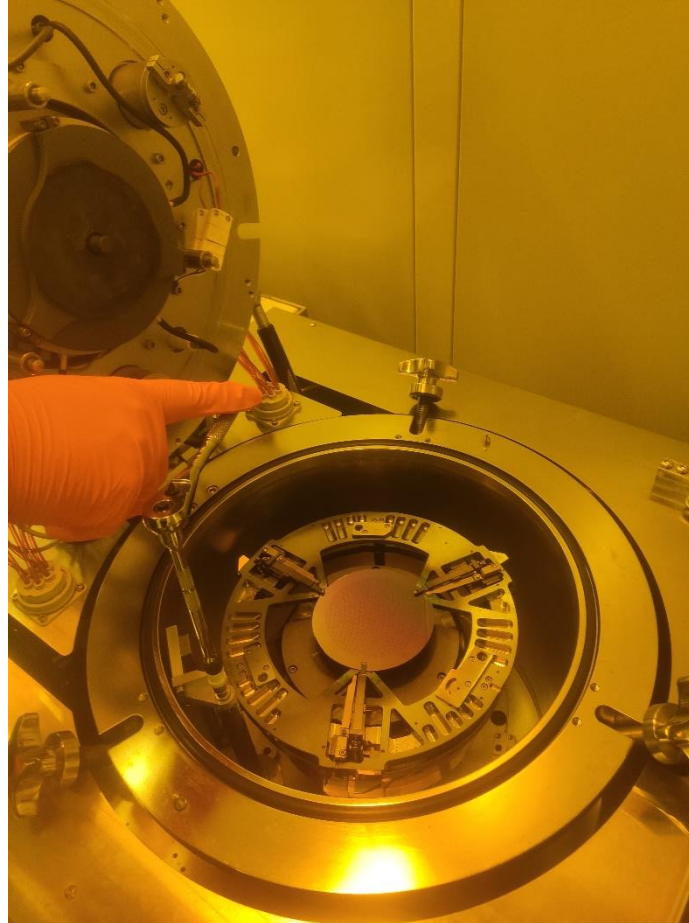
- Nanomechanics
- Single cell mechanics

Wafer bonding

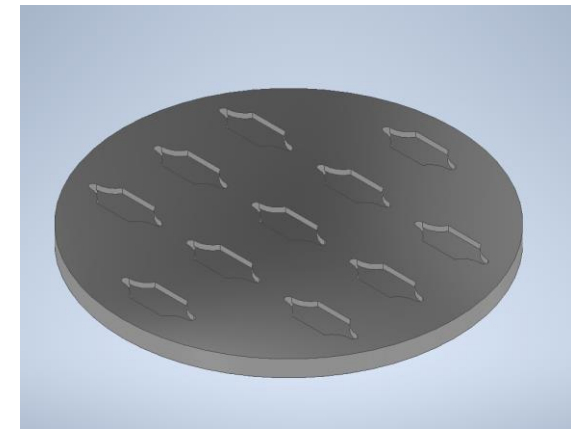
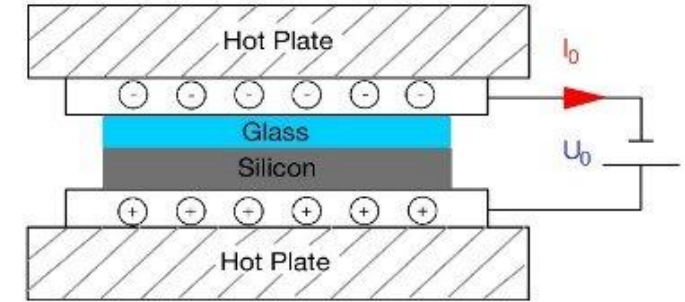
Schematic of wafer bonding and a typical structured wafer mockup



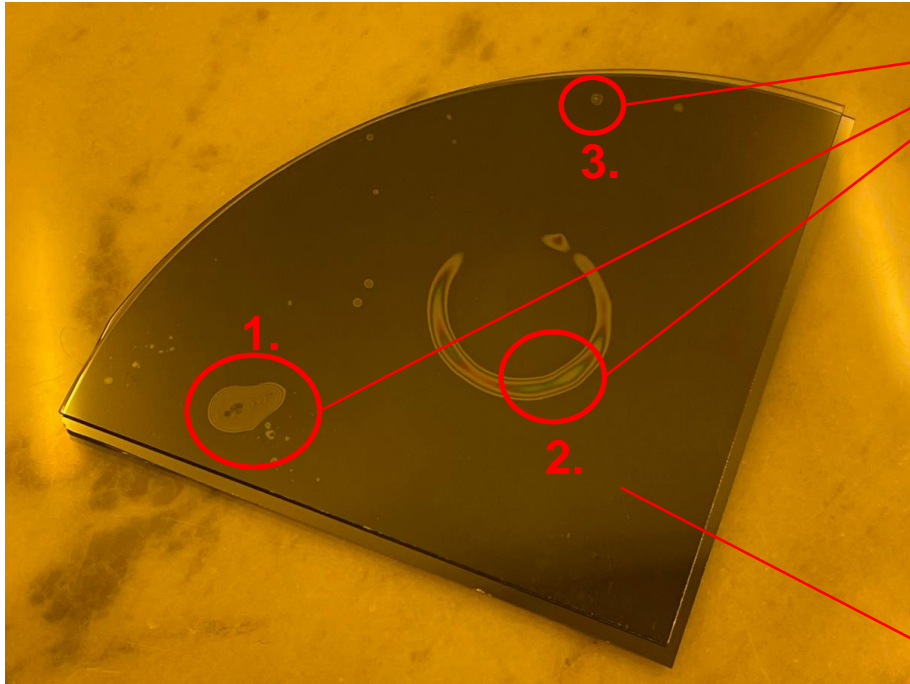
Süss SB6L type wafer bonder



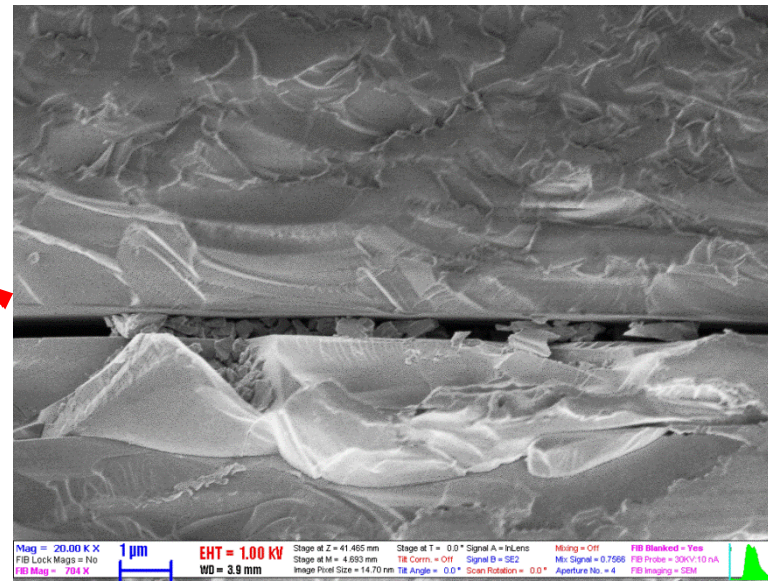
Si and Borofloat wafers aligned for bonding in the fixture



Wafer bonding



¼ of a 4" Si wafer bonded with borosilica glass for test purposes



Reasons for unsuccessful bonding:

1. Large particle contamination
2. Small contamination
3. Improper top tool pressure



Successful anodic bonding between wafer surfaces

Future plans

1. During the next semester I will study more of the **technological processes** required to produce MEMS devices
2. Comprehensive overview on **tissue / cell biomechanics** to form the basis for some of my thesis points
3. **Tissue classification** using **Artificial Intelligence** (AI - MI)
4. There are two (possibly three) publications already in the works from the above described topics

Publications

1. P. L. Neumann, J. Radó, J. M. Bozorádi, J. Volk, AlGaIn/GaN heterostructure based 3-dimensional force sensors, MICRO AND NANO ENGINEERING 19, 100198 , 8 p. (2023)
2. Zs. Szomor, J. M. Bozorádi, B. Beiler, Z. Szabó, P. Fürjes, In-situ optical characterisation of droplet generation in two-phase microfluidic system, MNE-ES 2022 - Micro and Nano Engineering (MNE) & Eurosensors 2022 Conferences, Leuven, Belgium, 2022
3. J. M. Bozorádi, A. Nagy, J. Radó, P. Földesy, I. Bársony, G. Papp, Cs. Dücső, P. Fürjes, Characterisation tissue elasticity by MEMS force sensors, MNE-ES 2022 - Micro and Nano Engineering (MNE) & Eurosensors 2022 Conferences, Leuven, Belgium, 2022
4. Zoltán Szabó, Kitti Pankász, János Márk Bozorádi, Orsolya Hakkel, Szabolcs Bella, Bianka Fabinyi, Sandro Meucci, Péter Fürjes, Microfluidic Cuvette for Near Infrared Spectroscopy, Proceedings of Eurosensors 2023 Conference, Lecce, Italy, 2023 (MDPI Proceedings ...) (oral presentation)
5. **Bozorádi János Márk:** 3D MEMS erőmérő szenzorok alkalmazása biomechanikai vizsgálatokra, 36. OTDK Műszaki Tudományi Szekció, Egészségtudomány 1 Tagozat, II. HELYEZÉS

Courses completed:

- | | |
|---------------|---|
| 1. OATRMSK1ND | Ragasztás mentes szeletkötés |
| 2. OATPOAM1ND | Polimerek alkalmazása a mikrotechnológiában |
| 3. OATANTA1ND | Anyagtudomány alapjai |

Thank you for your attention!