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SpineRepair RTD 2013

FNSNF

# Soft Implantable Electrode Arrays for Spinal Tissue Interfacing

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE


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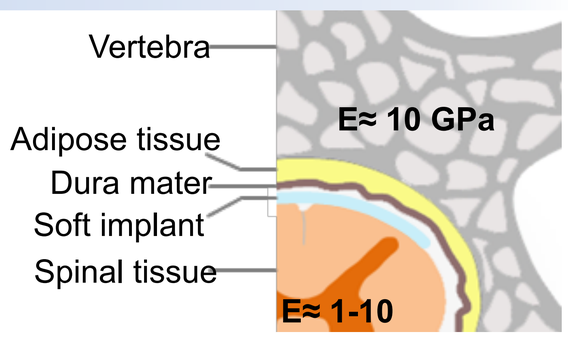
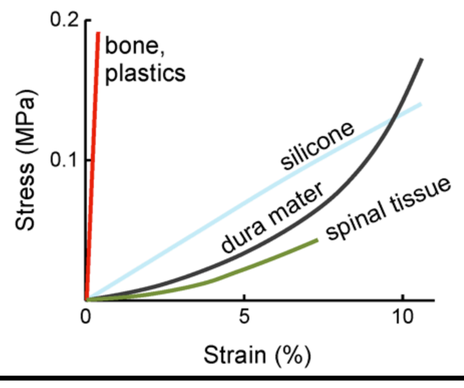
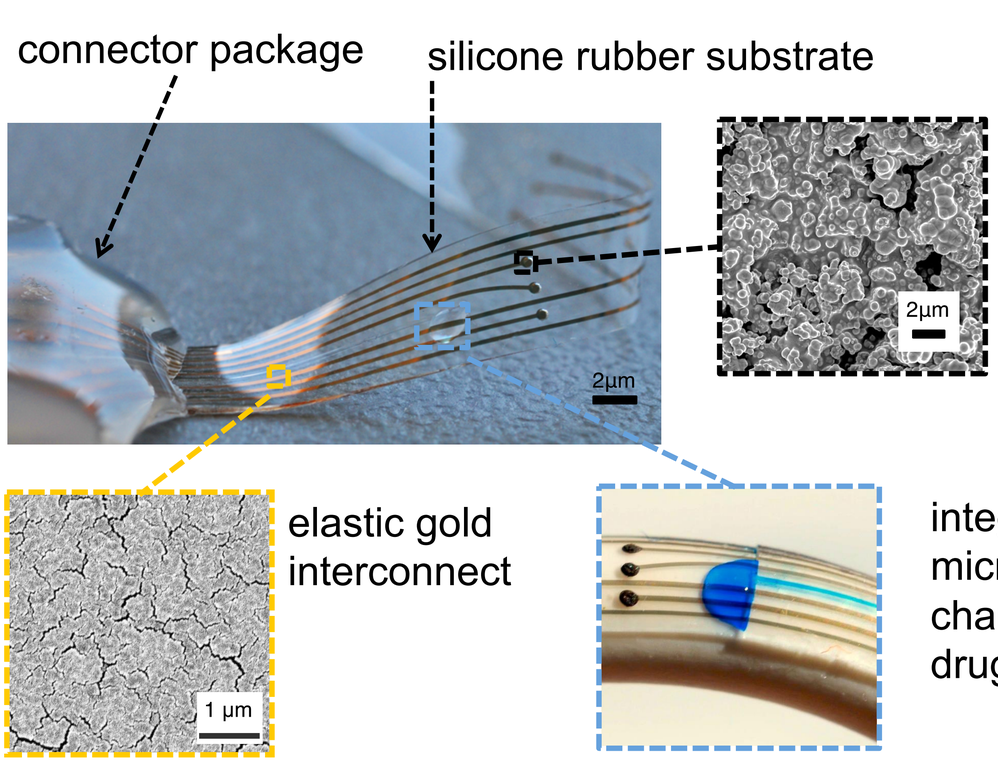
## Context

- Neuromodulation of Spinal Cord *prosthetic rehabilitation*
- Implantable system *intrathecal space*
- High Biointegration *using tissue matched engineering materials*
- Multimodal Neuromodulation *electrical, chemical and optical(transparency)*



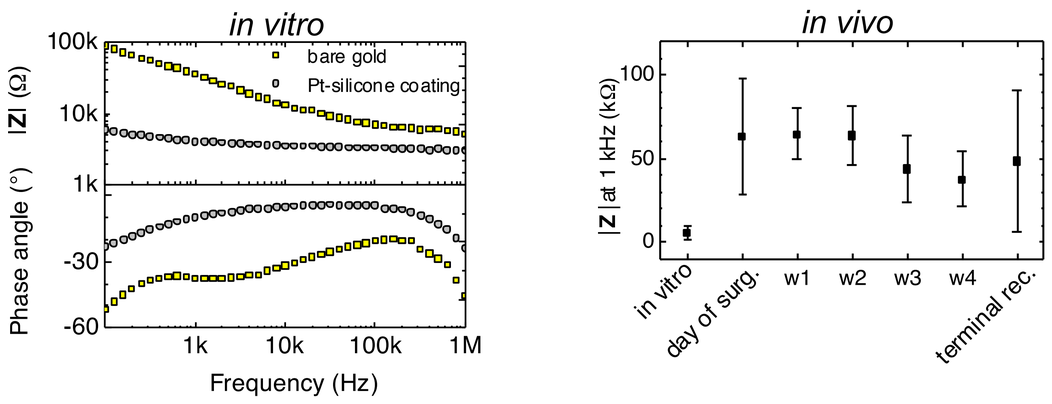




## Implantable Technology

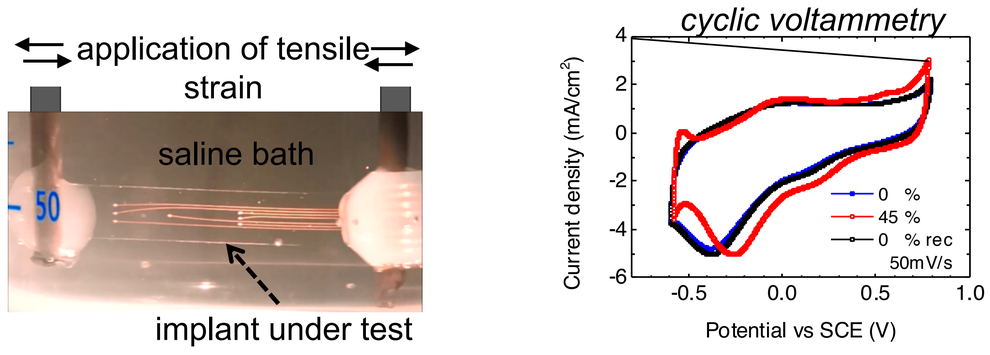



## Electrical/Mechanical characterization

Impedance of electrodes with composite coating

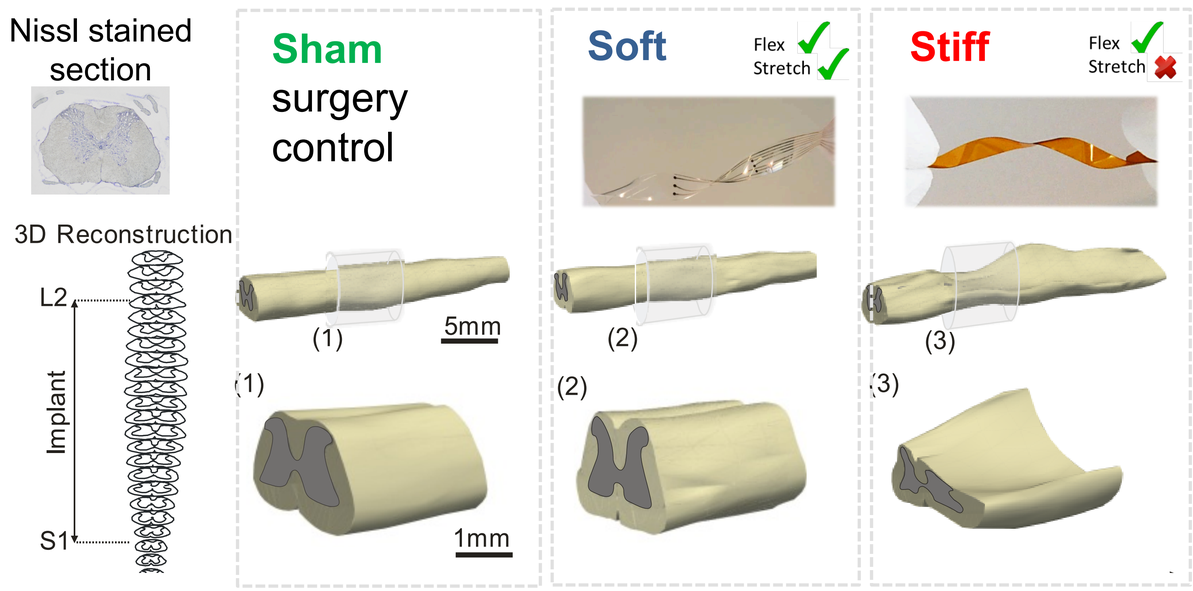



Electrodes survive large stretch (mimicking *in vivo* conditions)




## Biointegration of soft implant

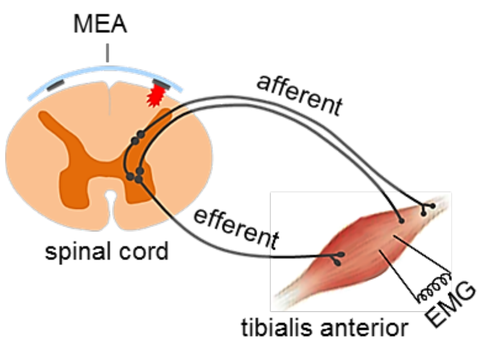
- Sub-dural placement of **Stiff** and **Soft** (+ **Sham** surgery) implants
- Healthy rodent model
- Spinal cords explanted and reconstructed in 3D (6w post implantation)

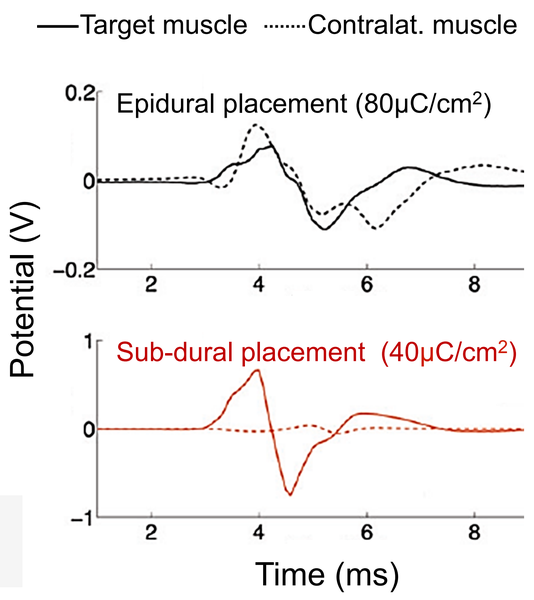



The silicone implant causes no long term damage to spinal cord

## Results

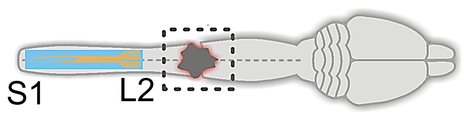
Electrical stimulation produces targeted muscle recruitment

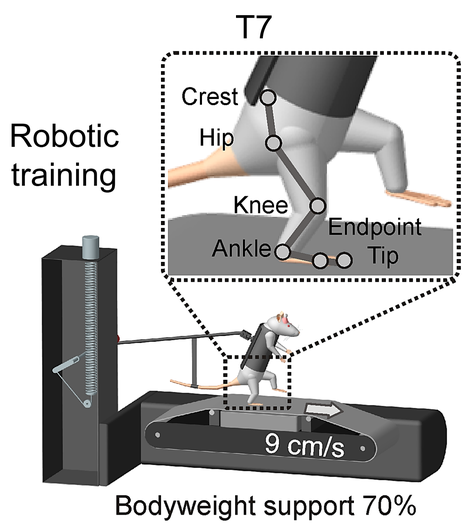


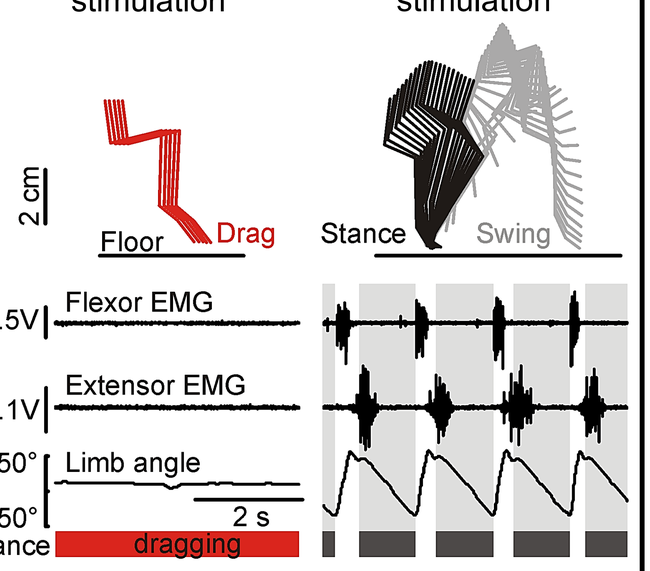




Sub-dural electrode placement increases stimulation specificity and efficiency

*Contusion model of Spinal Cord Injury (rat)




Electrochemical modulation restored locomotion post paralyzing spinal cord injury

## Conclusions

- We have developed a stretchable neural array for stimulating circuits in the spinal cord
- The array can be used for Functional Electrical Stimulation (FES) as part of rehabilitation routines in SCI rat models


Van den Brand, et al. (2012). "Restoring Voluntary Control of Locomotion after Paralyzing Spinal Cord Injury." Science 336(6085): 1182-1185.

Minev, I. R. and S. P. Lacour (2010). "Impedance spectroscopy on stretchable microelectrode arrays." Applied Physics Letters 97(4): 043707.

I. R. Minev, P. Musienko, A. Hirsch, Q. Barraud and N. Wenger et al. Biomaterials. Electronic dura mater for long-term multimodal neural interfaces, in Science (New York, N.Y.), vol. 347, num. 6218, p. 159-63, 2015.