Keynote Lecture

**Imitating cricket mechanosensory hairs: dream or reality?**

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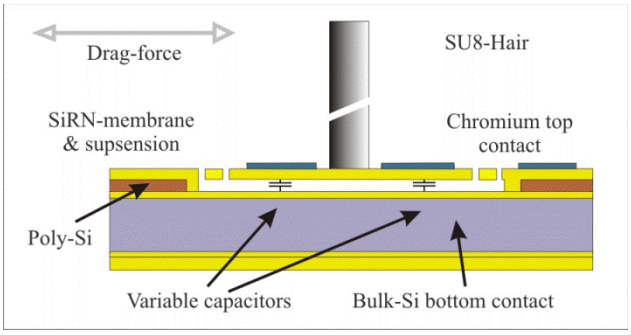
MEMS offers exciting possibilities for bio-inspired mechanosensors. Over the last years we have been working on cricket inspired hair-sensors for flow observations. In stimulating interactions within EU consortia important insights have surfaced and MEMS sensors with demonstrated acoustic sensitivity have been presented.

However, our sensors are readily outperformed by nature. So the central question is how to build hair-sensors that can take on the competition with nature. What needs to be done to improve their sensitivity? How have the natural sensors developed over time and to which perceptual tasks have they become adapted? Can MEMS sensors be made accordingly and does this make sense from an application viewpoint? This knowledge, input by biologists and bio-physicists into biomimetic activities is of paramount importance to the designers and engineers.

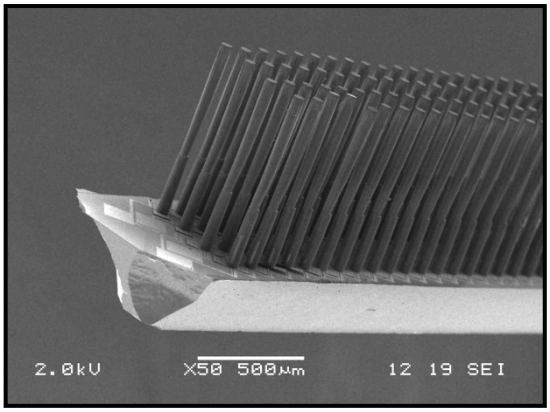
Working with biological material, given its tendency to display high variance in space and time (e.g. stiffening of biological tissue after preparation for experiments) often turns out to be difficult or hard to interpret. This is where MEMS can help biology as well. Where biology and biophysics deliver important insights to (MEMS-) engineers, reversely very usable and relatively predictable structures can be provided by (MEMS-) engineers to biologists aiding in understanding the more complex biological systems. In this respect the authors collaborate on various aspects of flow-observation and characterisation of biological and artificial mechanosensors. E.g. sinusoidal flows around hairs and hair-arrays are subject of study. Future work will include characterisation of viscous coupling between mechanosensory hairs.

Beyond bio-inspiration MEMS-sensors have possibilities that are not necessarily available in biological model-systems, e.g. dynamic sensor adaptation and beneficial use of nonlinearity (parametric electromechanical filtering and stochastic resonance) which will be discussed as well.

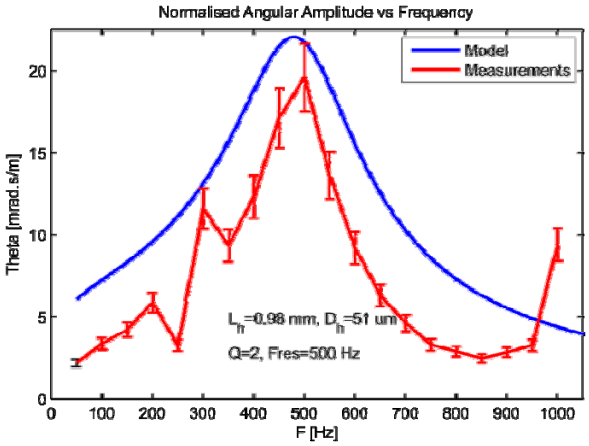
1. Steinmann, Casas, Krijnen, Dangles (2006) J Exp Biol 209: 4398-4408
2. Krijnen, Lammerink, Wiegerink, Casas (2007) Proc IEEE Sensors 2007, 28-31 Oct 2007, Atlanta
3. Krijnen, Dijkstra, Baar, Shankar, Kuipers, de Boer, Altpeter, Lammerink, Wiegerink (2006) Nanotechnology 17: S84-S89



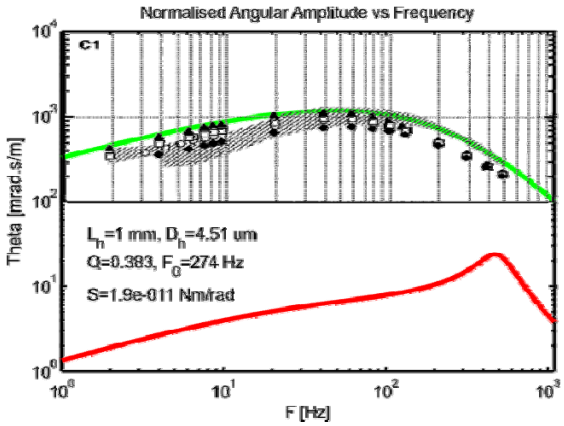

Schematic representation of an artificial hair-sensor



with capacitive read-out.

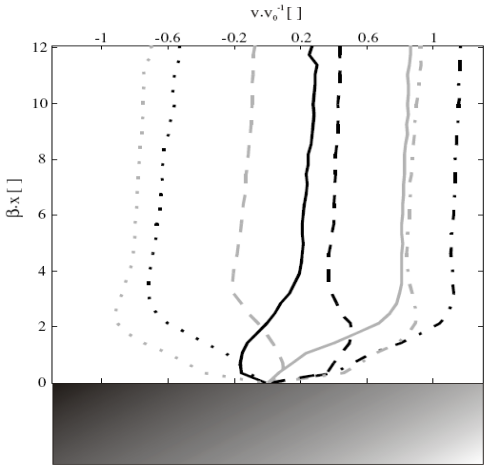



Measured and predicted sensitivity of artificial hair-sensors as a function of frequency.

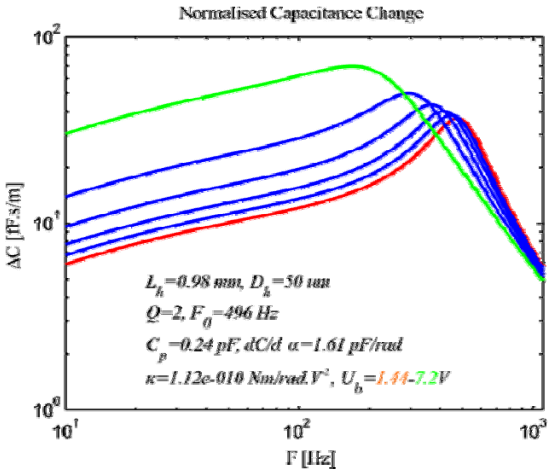



Comparison between cricket and MEMS hair-sensor deflections as a function of frequency.

Realised MEMS hair-sensor array on artificial “cercus”




Measured sinusoidal flow-profile over a MEMS structure




DC-bias induced adaptivity (model).