mc10

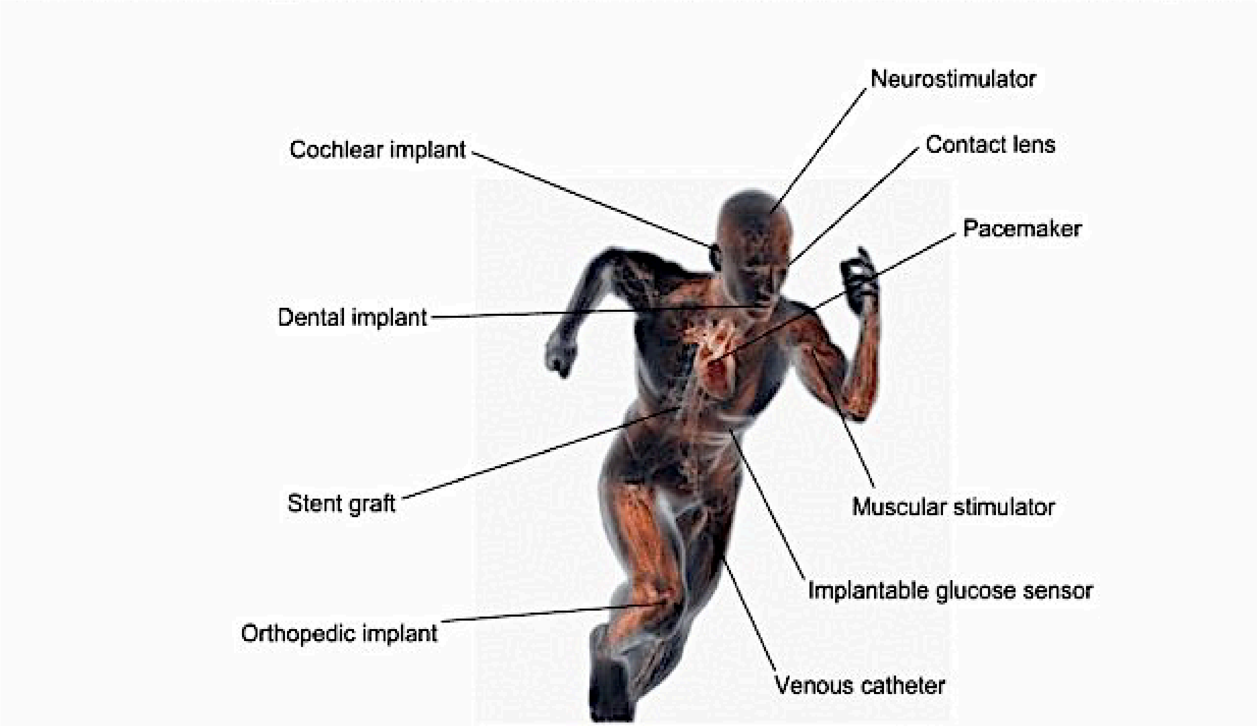
reshaping electronics

Soft Stretchable Biointegrated Electronics

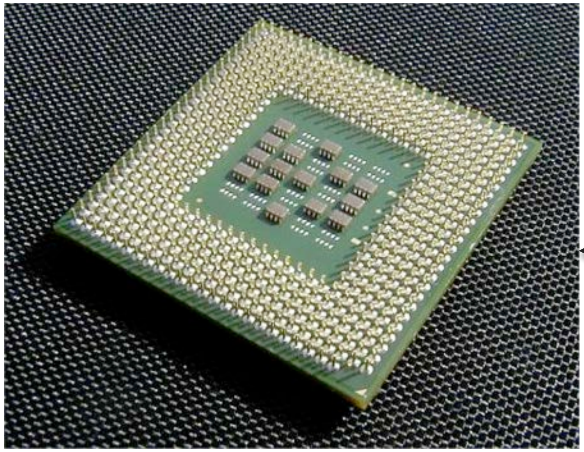
Frontiers of Engineering

Roozbeh Ghaffari, PhD
MC10 Inc
Co-founder, Vice President of Technology
MIT Research Laboratory of Electronics
June 3, 2015

Biointegrated Devices and the Human Body



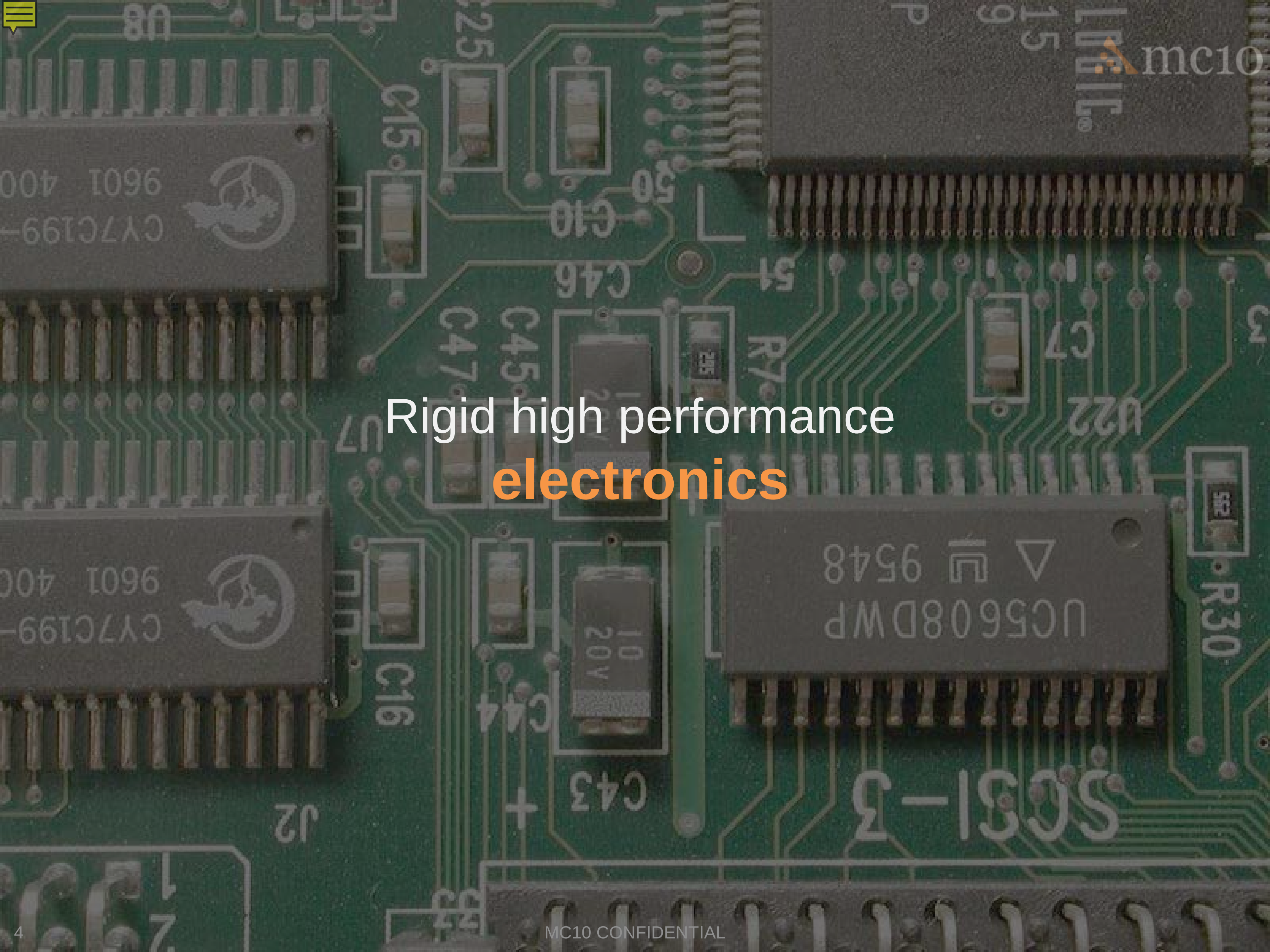
Fundamental Mismatch



Hard | Rigid | Flat

6-Orders of Magnitude Difference in Hardness

Soft | Flexible | Curvy



Rigid high performance **electronics**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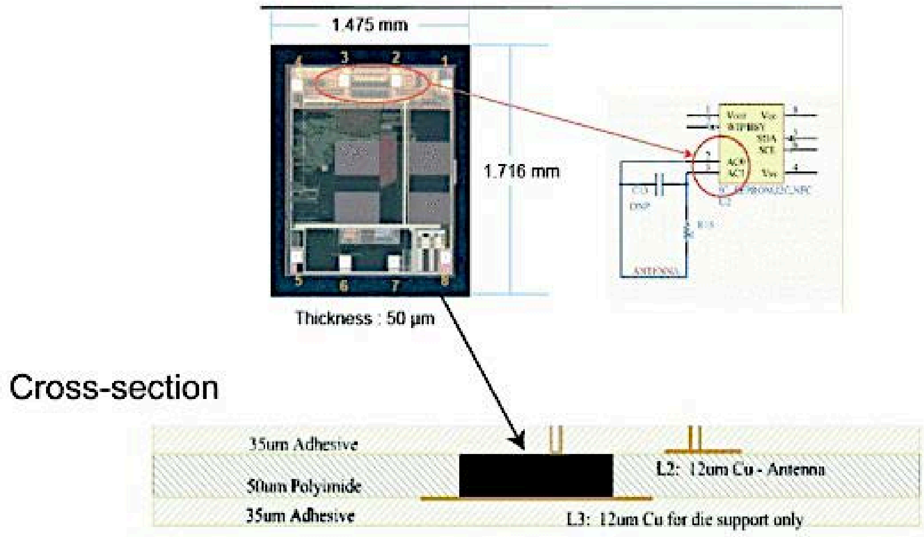
Reshape them into human-compatible form factors that
stretch, bend and twist

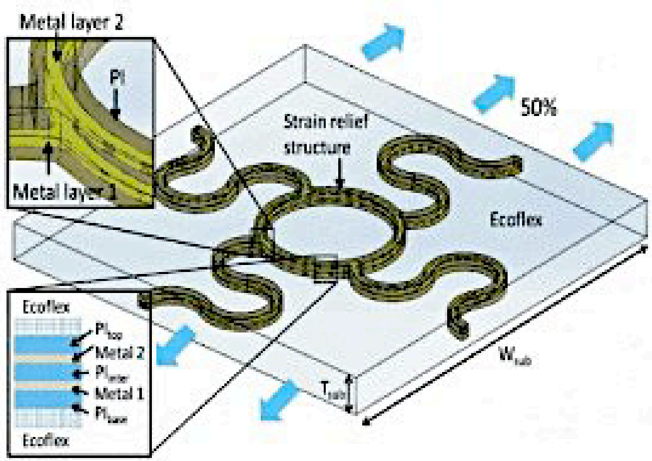
Core Technology: Embedded Unpackaged Die



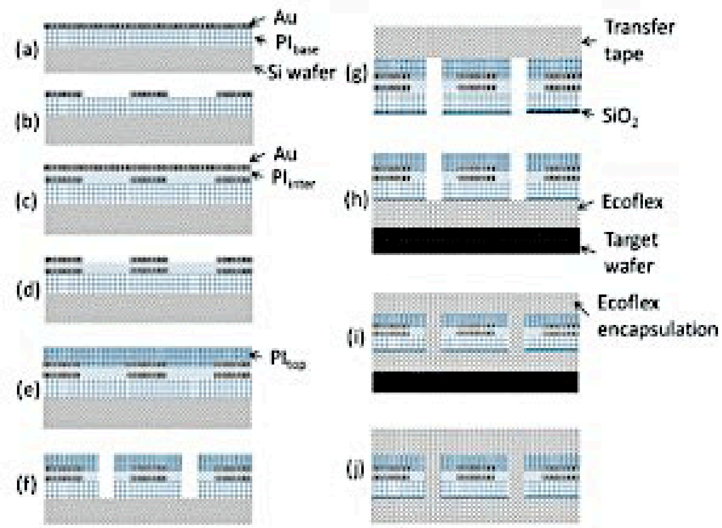
Dalal & Ghaffari, In prep

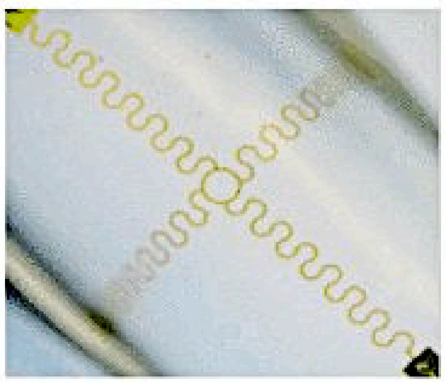
Core Technology: Spring-like Interconnects

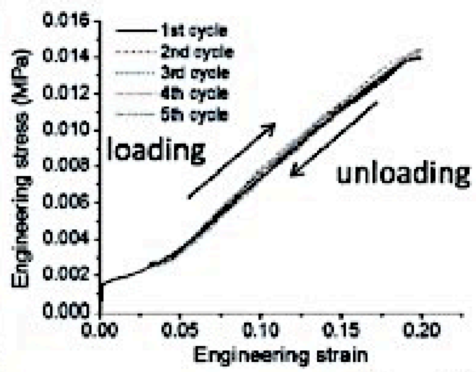
Multi-layered metal interconnects



Process flow for multi-layered device fabrication

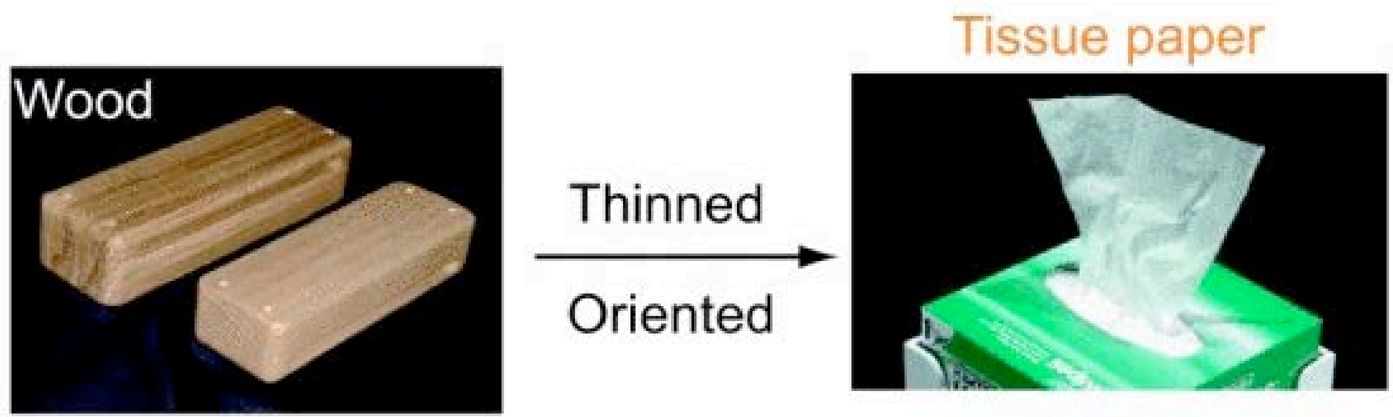






Hsu, Ghaffari et al, IEEE 2013

High Performance Stretchable Electronics



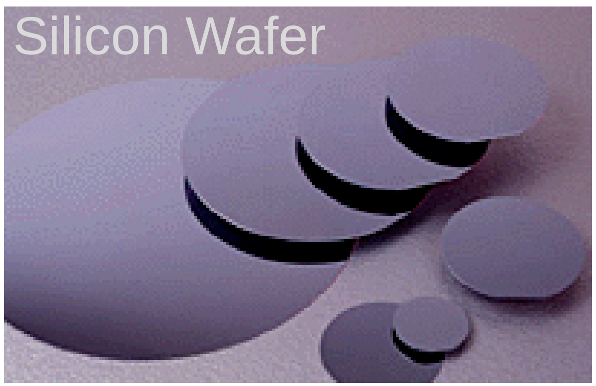
Ultrathin Stretchable Electronics

Wood

Thinned

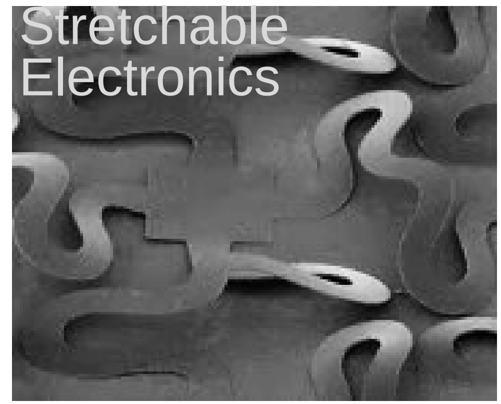
Oriented

Tissue Paper



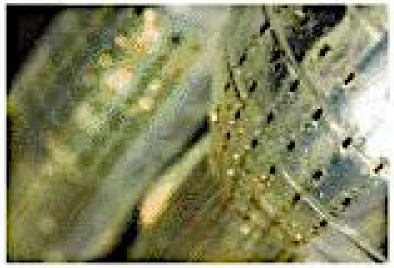
Thinned

Oriented



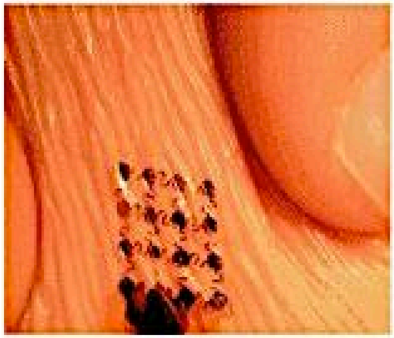
Applications of Stretchable Bioelectronics

Smart Catheters
and Prosthetics



Cardiac Sensor
Sheets

Epidermal
Electronics



Paper-based
Sensors/Electronics

Applications of Stretchable Bioelectronics

Smart Catheters and Prosthetics

Cardiac Sensor Sheets

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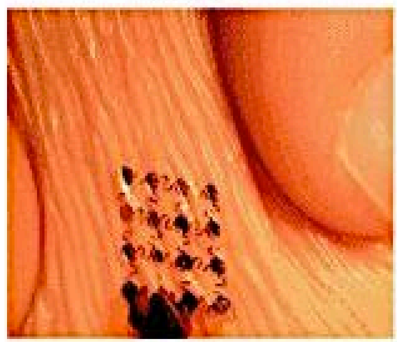
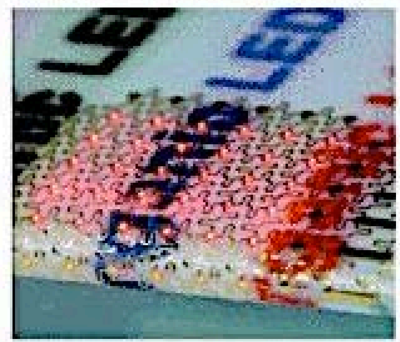
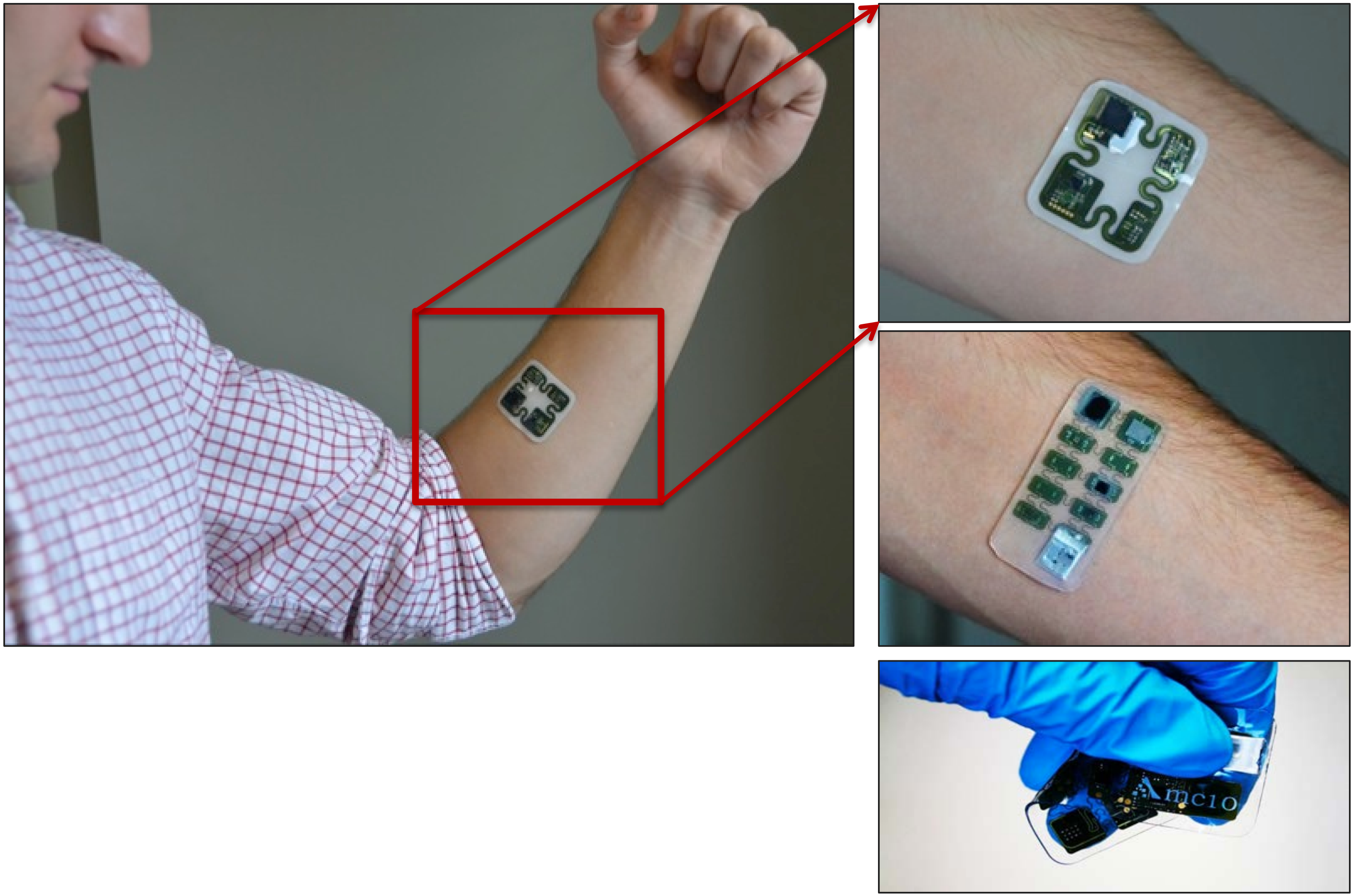


Paper-based Sensors/Electronics

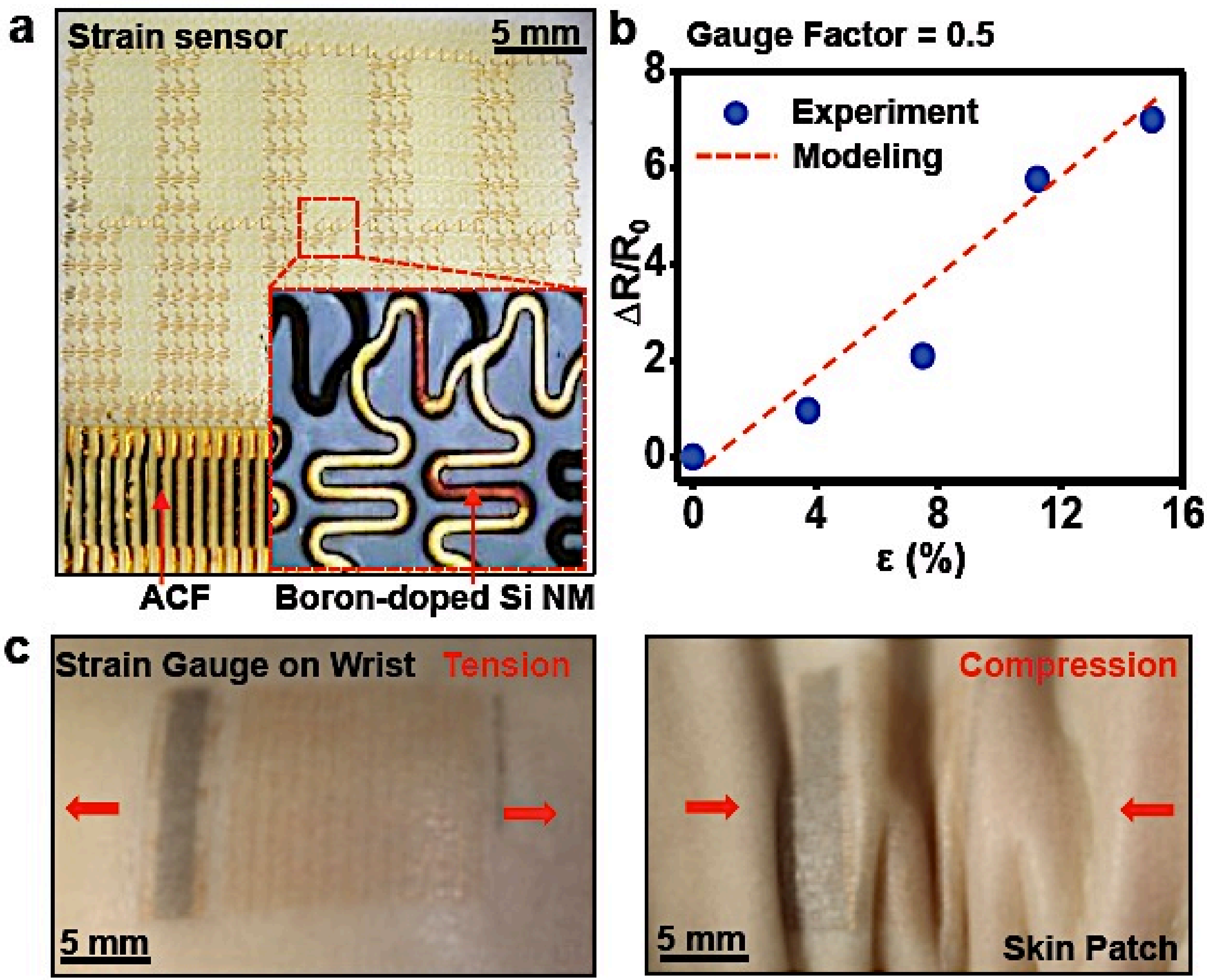


Wearables Today…

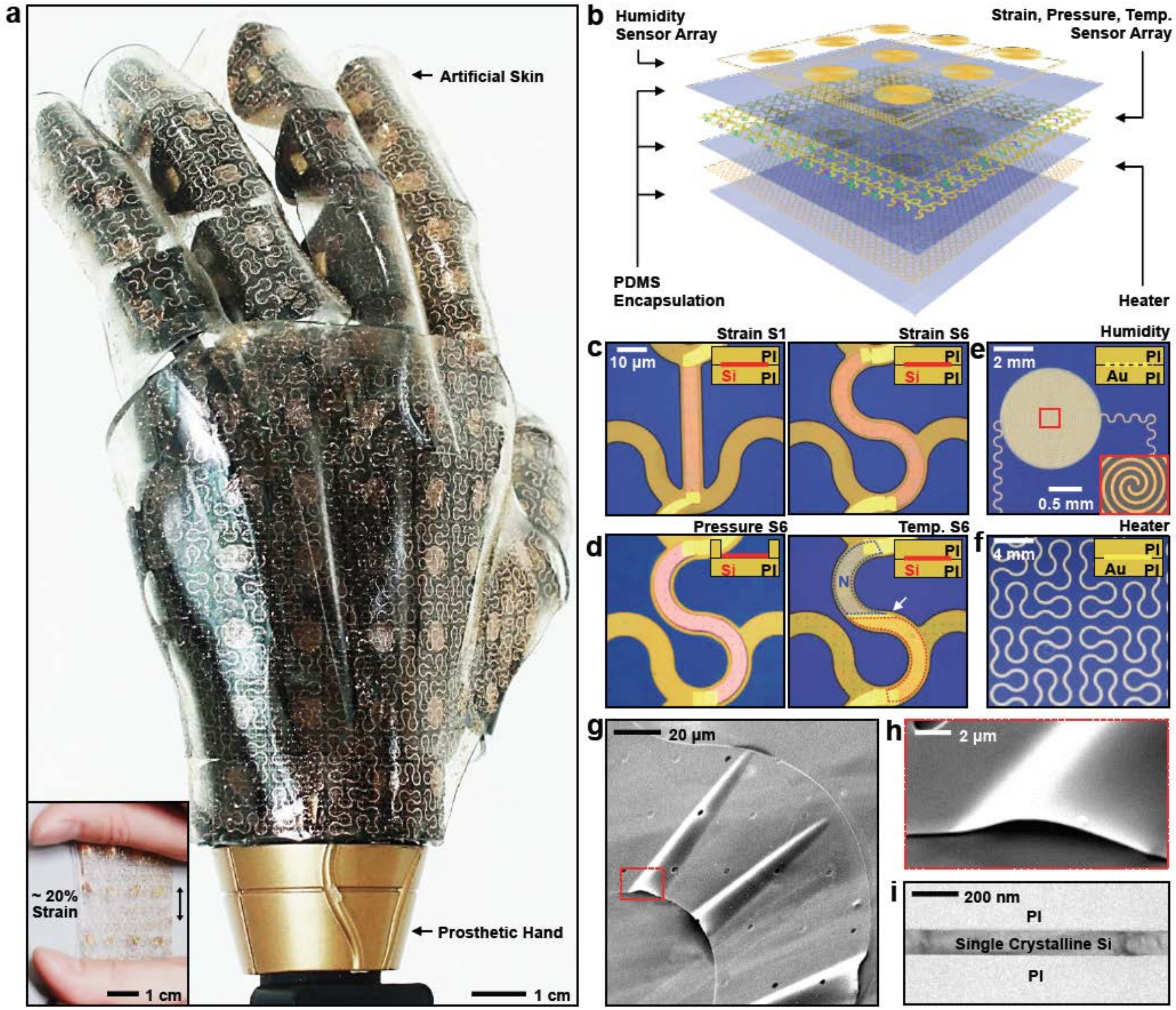
Stretchable Bioelectronics on the Body



Strain Gauge Sensor Arrays

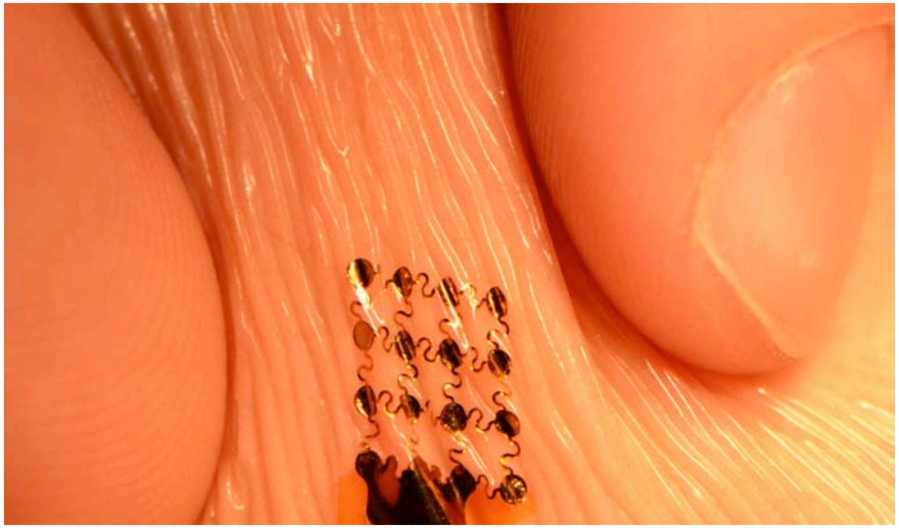


Prosthetic Skin Instrumented with Sensors

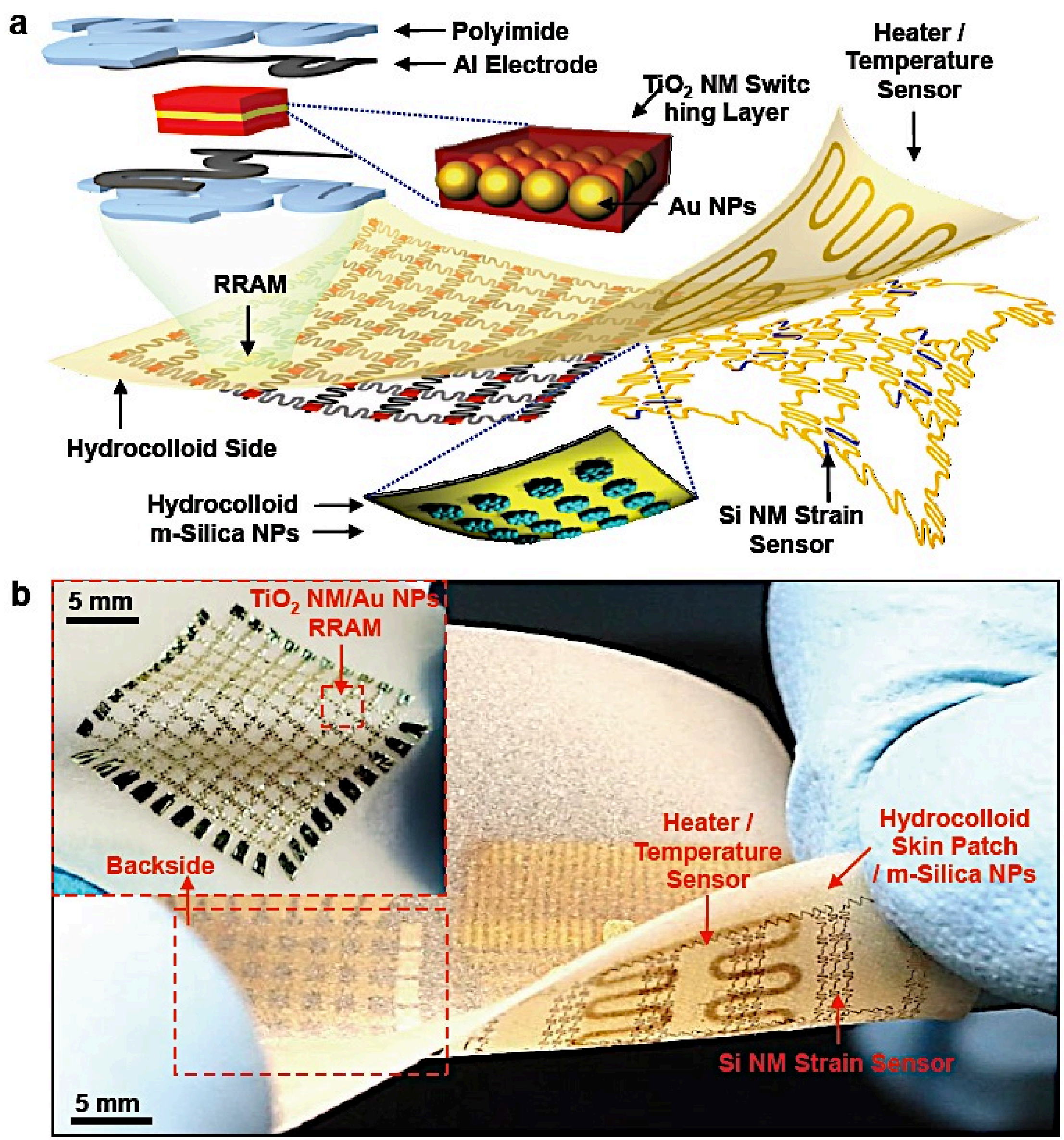


Kim et al, Nature Communications 2015

Skin Instrumented with Sensors



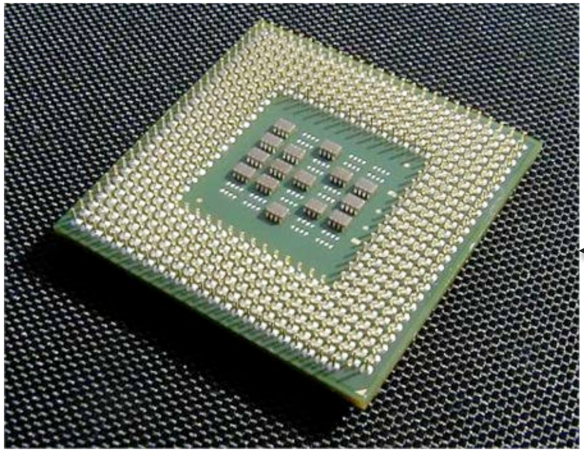
Drug Delivery Through Epidermal Bioelectronics



Son et al, Nature Nanotechnology 2014

Fundamental Mismatch

6-Orders of Magnitude Difference in Hardness



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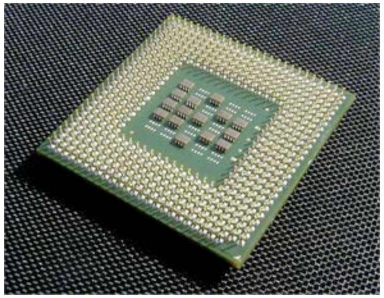
Bridging Gap Between Electronics and Medicine



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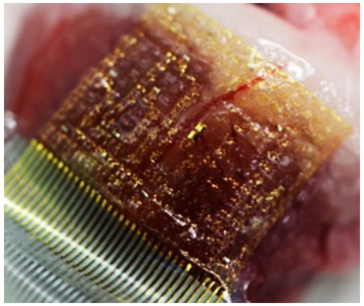

The Future of Bio-Electronics…

“Hacking the Human OS”

Hacking the Human OS > Reading the Code > Sensors

A Temporary Tattoo That Senses Through Your Skin

The Biostamp can replace today's clunky biomedical sensors

By Tekla S. Perry

Posted 29 May 2015 | 18:08 GMT

MC10 Team

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Soft Stretchable Biointegrated Electronics

Frontiers of Engineering

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MIT Research Laboratory of Electronics
June 3, 2015

Future of Wearable Technology

nature nanotechnology

ARTICLES

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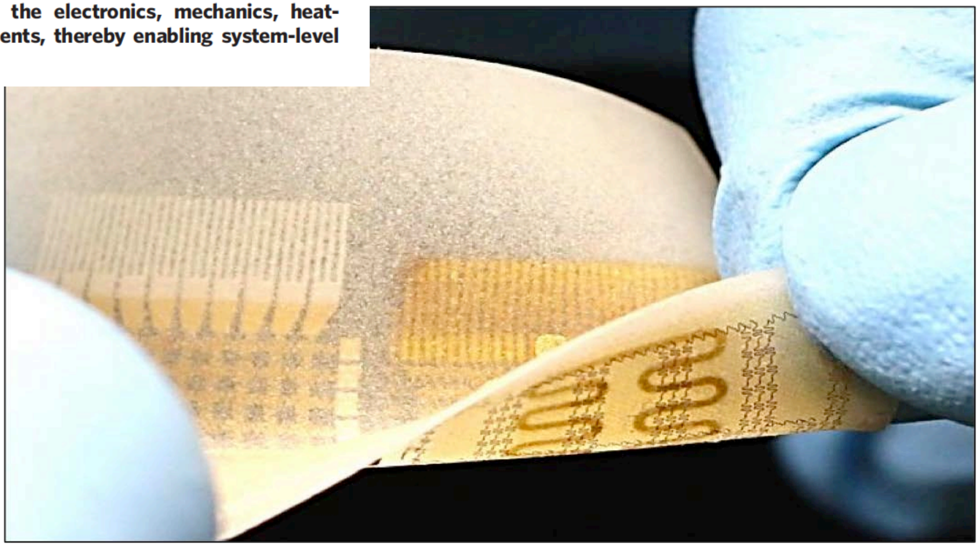
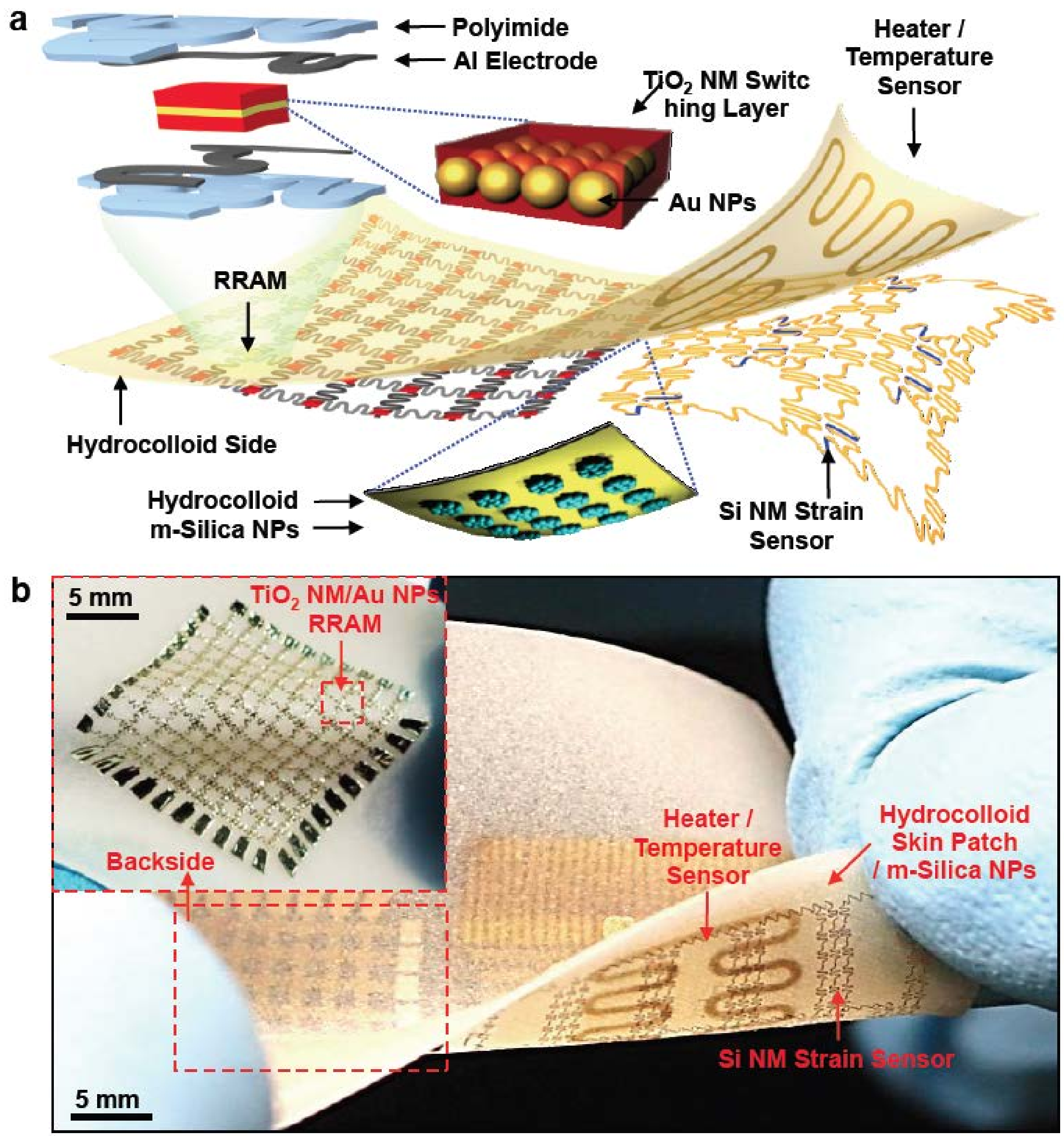
Multifunctional wearable devices for diagnosis and therapy of movement disorders

Donghee Son[1,2†], Jongha Lee[1,2†], Shutao Qiao[3], Roozbeh Ghaffari[4], Jaemin Kim[1,2], Ji Eun Lee[1,2], Changyeong Song[1,2], Seok Joo Kim[1,2], Dong Jun Lee[1,2], Samuel Woojoo Jun[1,2], Shixuan Yang[3], Minjoon Park[1,2], Jiho Shin[1,2], Kyungsik Do[1,2], Mincheol Lee[1,2], Kwanghun Kang[1,2], Cheol Seong Hwang[5], Nanshu Lu[3], Taeghwan Hyeon[1,2] and Dae-Hyeong Kim[1,2*]

Wearable systems that monitor muscle activity, store data and deliver feedback therapy are the next frontier in personalized medicine and healthcare. However, technical challenges, such as the fabrication of high-performance, energy-efficient sensors and memory modules that are in intimate mechanical contact with soft tissues, in conjunction with controlled delivery of therapeutic agents, limit the wide-scale adoption of such systems. Here, we describe materials, mechanics and designs for multifunctional, wearable-on-the-skin systems that address these challenges via monolithic integration of nanomembranes fabricated with a top-down approach, nanoparticles assembled by bottom-up methods, and stretchable electronics on a tissue-like polymeric substrate. Representative examples of such systems include physiological sensors, non-volatile memory and drug-release actuators. Quantitative analyses of the electronics, mechanics, heat-transfer and drug-diffusion characteristics validate the operation of individual components, thereby enabling system-level multifunctionalities.




a
Polyimide
Al Electrode
TiO2 NM Switc hing Layer
Heater / Temperature Sensor
Au NPs
RRAM
Hydrocolloid Side
Hydrocolloid
m-Silica NPs
Si NM Strain Sensor
b
5 mm
TiO2 NM/Au NPs RRAM
Backside
Heater / Temperature Sensor
Hydrocolloid Skin Patch / m-Silica NPs
Si NM Strain Sensor
5 mm