Flexible Sensor Circuits Fabricated by Additive Printing

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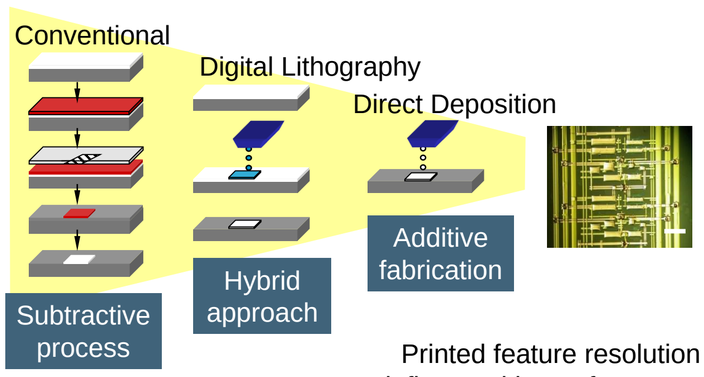
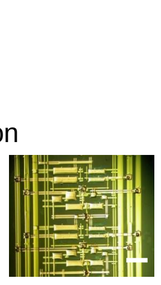
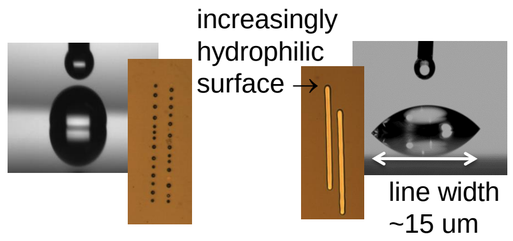
Additive printing for electronics

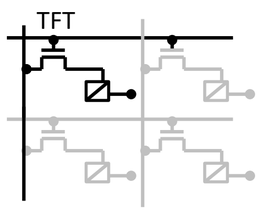


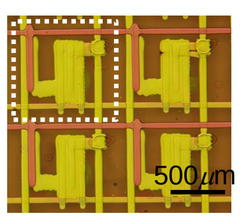


Printed feature resolution is influenced by surface energy



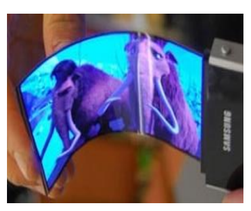
Active matrix arrays





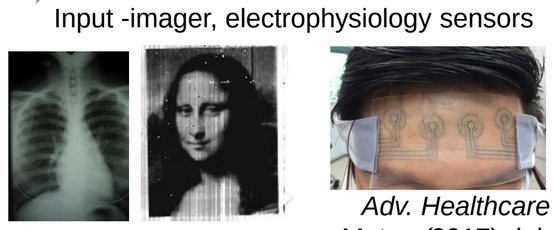
M + N lines
Instead of M x N

Output- display, actuator



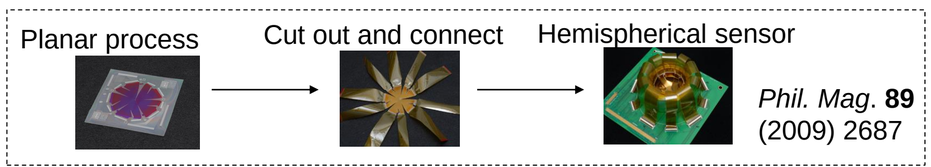
Braille reader

Input -imager, electrophysiology sensors



Appl. Phys. Lett. **92**(2008) 213303
Adv. Mater. **21** (2009) 1855
ACS Appl. Mater. Interfaces **9** (2017) 1654

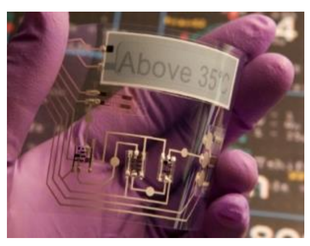
Adv. Healthcare Mater. (2017) doi: 10.1002/adhm.20 1700552

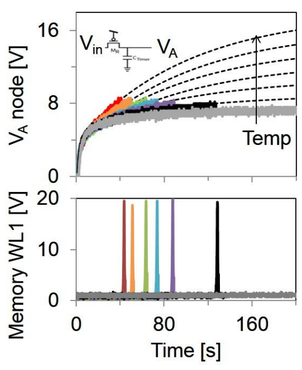


Phil. Mag. **89** (2009) 2687

Demonstration of printed systems

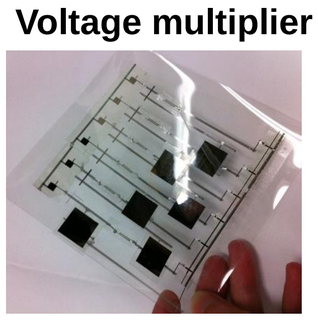
Temperature dose tag

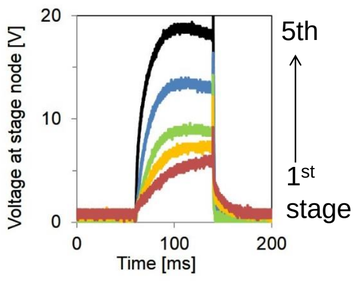




Sci Rep 2015, 5, 13457.

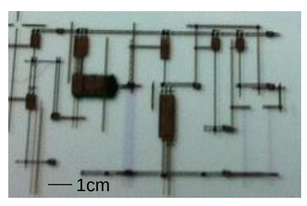
Voltage multiplier

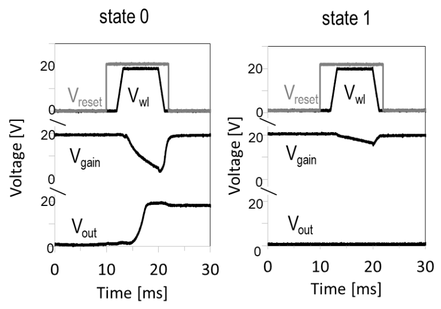




Flexible Printed Electronics (2016) 1, 015002.

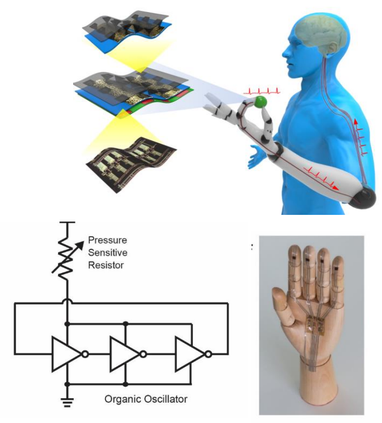
Memory readout circuit



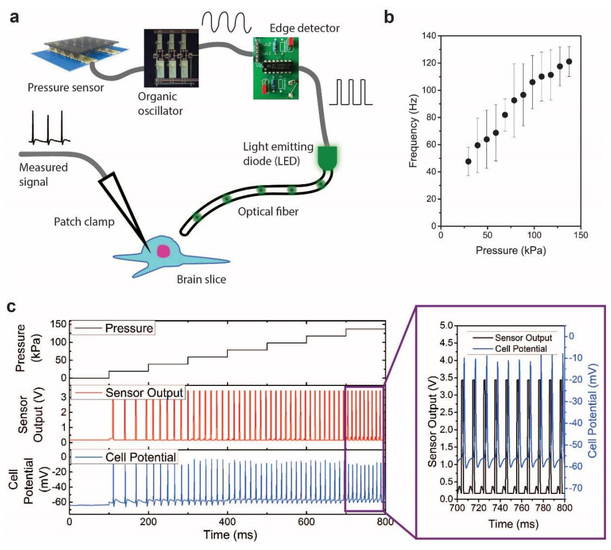


IEEE Transactions on Electron Devices (2017) 64, 1981.

Biomimetic mechanoreceptor, *Science* (2015) 350, 313.

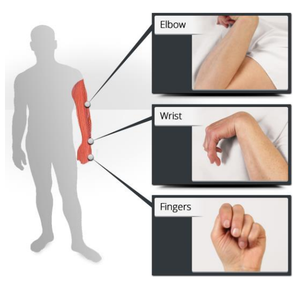


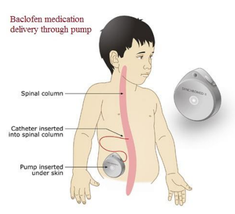
In collaboration with Zhenan Bao group



Example of a medical application: enabling objective assessment of neuromuscular disorders

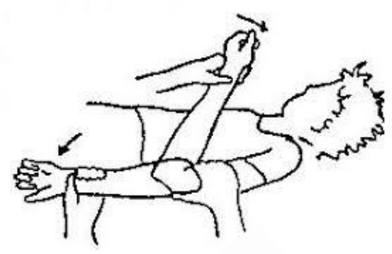
Need to augment spasticity diagnosis:
Spatiscity -involuntary activation of muscle, very prevalent in patient with neuromuscular disorders such as stroke, traumatic brain injury, cerebral palsy, etc. affect 764K in US; 17M world wide

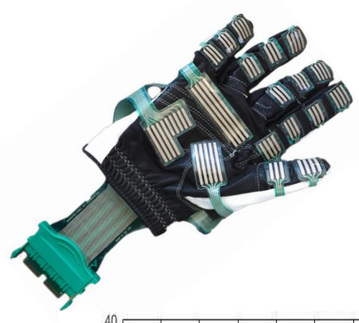


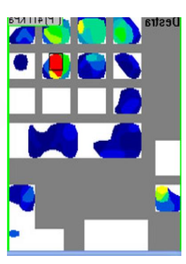


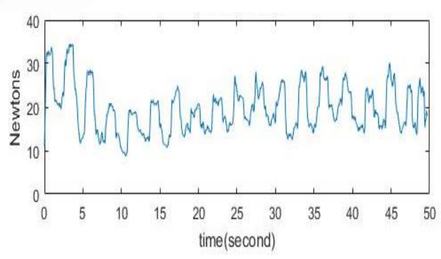
Score	Modified Ashworth Scale (MAS)
0	No increase in muscle tone
1	Slight increase in muscle tone, with a catch and release at the end of the range of motion (ROM)
1+	Slight increase in muscle tone, followed by minimal resistance throughout the remainder of ROM
2	More marked increase in muscle tone through most of the ROM, but affected parts easily moved
3	Considerable increase in muscle tone, passive movement difficult
4	Affected part is rigid in both flexion and extension

Glove worn by the doctor during assessment:
-measure force and angular velocity
-Power to move a limb P=F*v

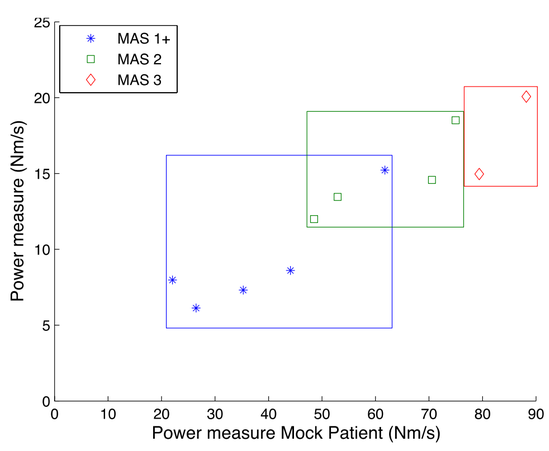








- Quantitative glove measurement allows comparison between rating trials, less dependence on rater perception
- Glove sensor improves the resolution of the spasticity assessment



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