ULTRALIGHT, COMPACT, AND STRETCHABLE ELECTRONICS FOR CONTINUOUS AND HIGH-QUALITY CARDIAC ASSESSMENT IN HIGH USER ACTIVITIES

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CREATING THE NEXT®

FLEX@TECH

CURRENT HEART MONITORS

- Clinical
  - Standard (12 lead)
  - Stress test
- Ambulatory
  - Holter monitor (3-5 lead)
  - Patch devices (single lead)
- Fitness trackers
  - Wrist
  - Chest strap

https://www.mayoclinic.org/

Photo https://urgentmednetwork.com

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LIMITATIONS

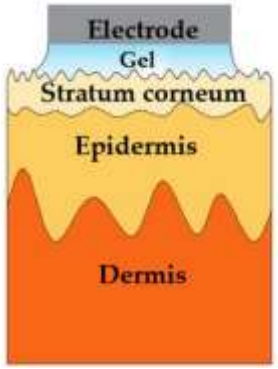
Form factor

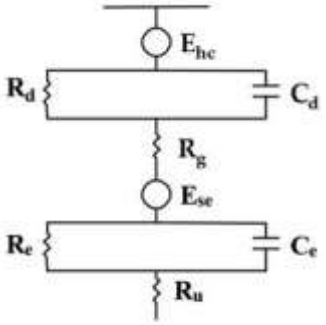
- Holter monitor still Gold-standard
- Wires and rigid components

https://www.mayoclinic.org/

Gel electrodes

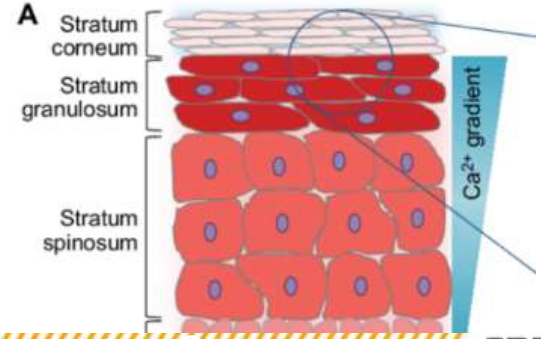
- Irritate skin
- Prone to motion artifacts





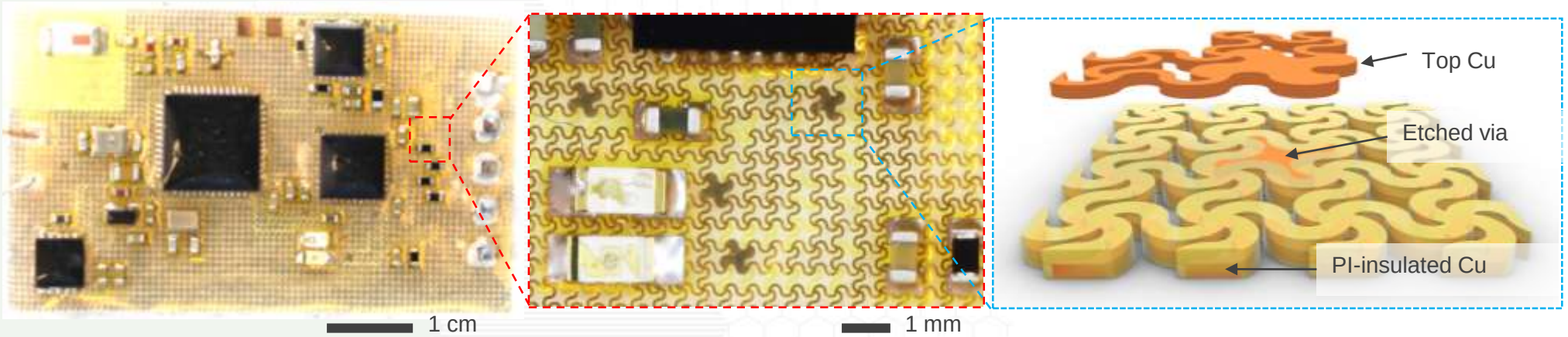
Contact impedance

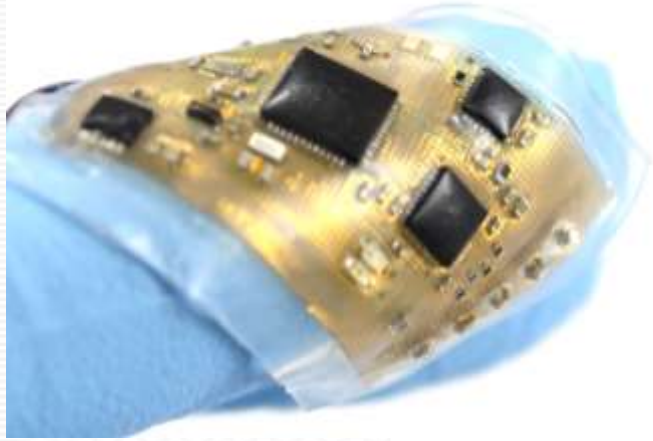
- Tight straps
- Sensitive to sweat
- Skin strain



Fu, Y.; Zhao, J.; Dong, Y.; Wang, X. Dry Electrodes for Human Bioelectrical Signal Monitoring. Sensors 2020, 20, 3651. https://doi.org/10.3390/s20133651
D. C. Blaydon and D. P. Kelsell, "Defective channels lead to an impaired skin barrier," *J Cell Sci,* vol. 127, no. Pt 20, pp. 4343-50, Oct 15 2014, doi: 10.1242/jcs.154633

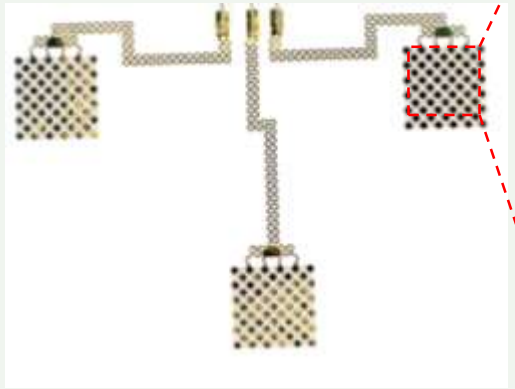
ADVANCES IN AMBULATORY ECG

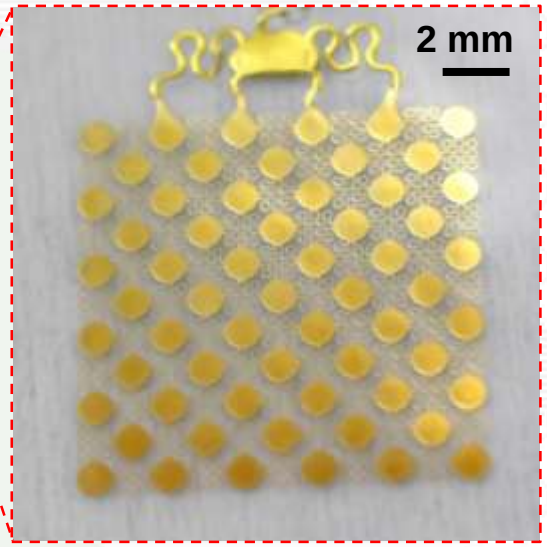


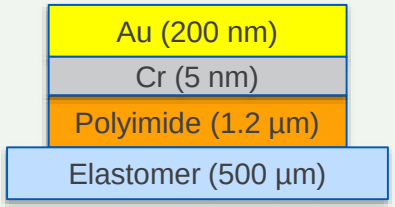


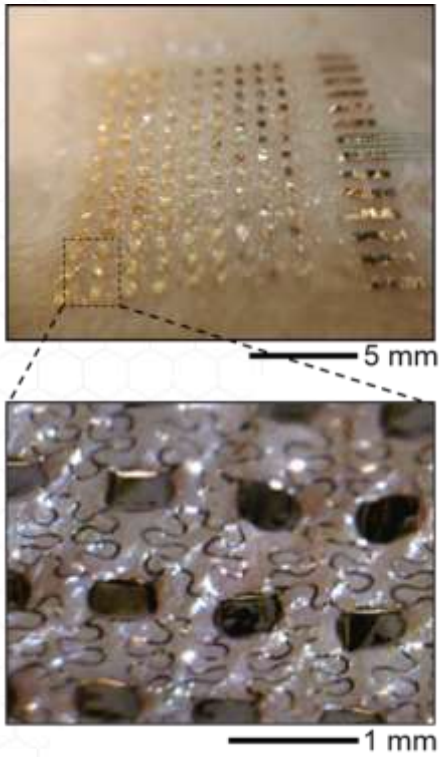
- Conformable
- Adhesive
- Wireless
- Low-profile
- Light-weight

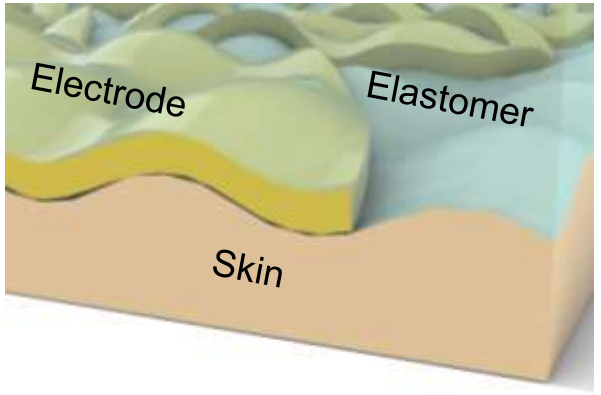
ADVANCES IN AMBULATORY ECG











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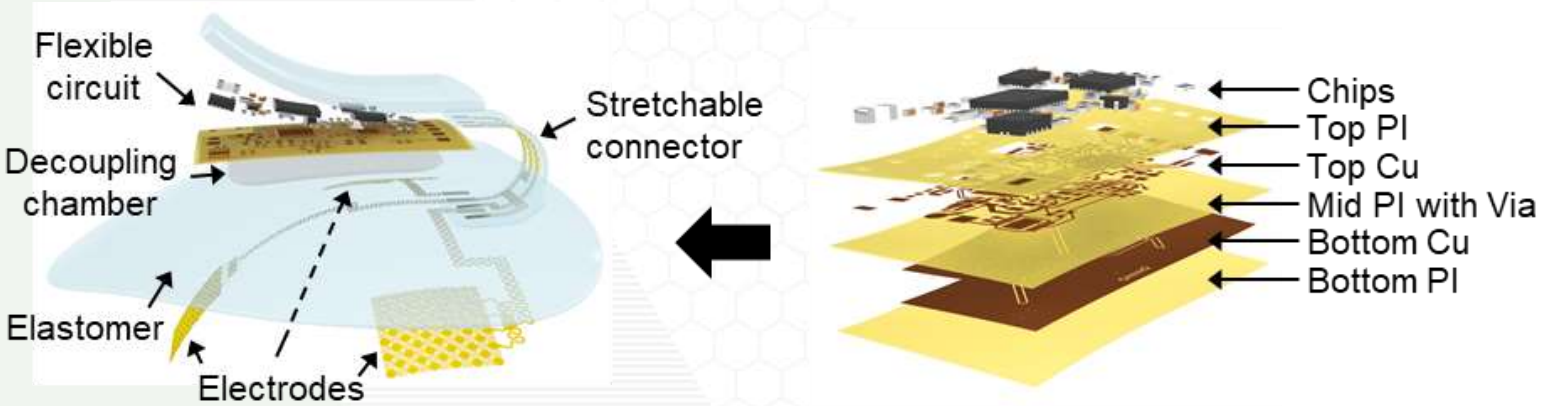

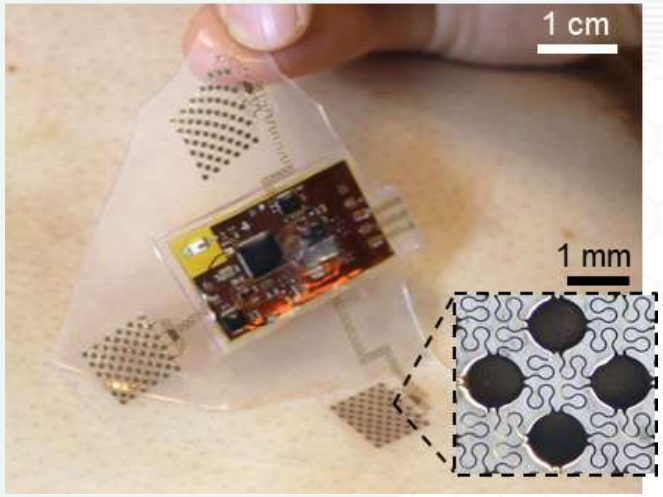

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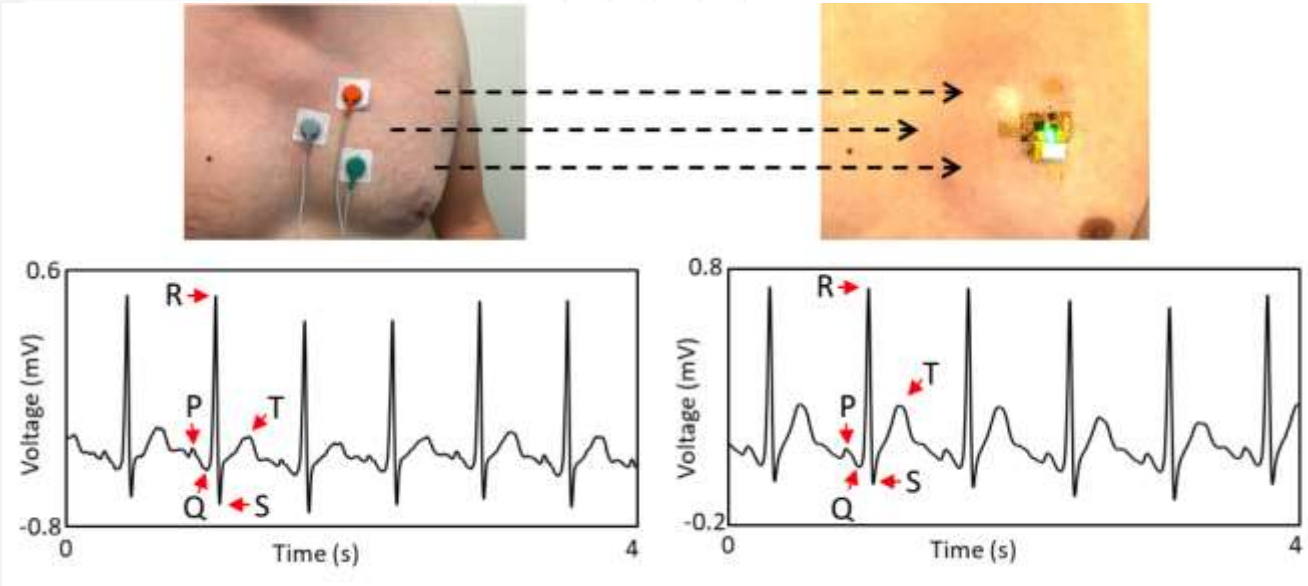
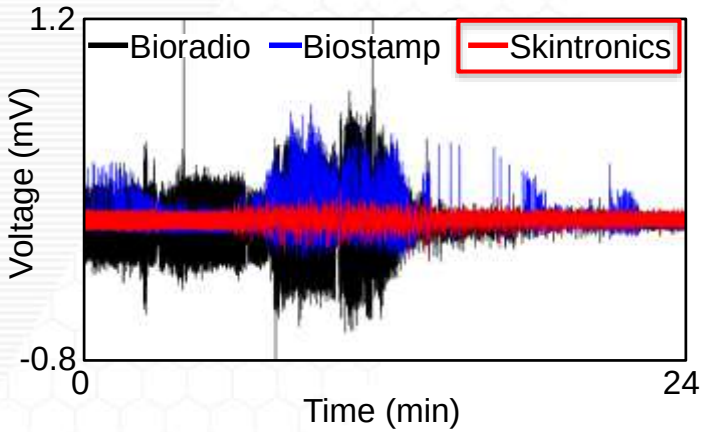
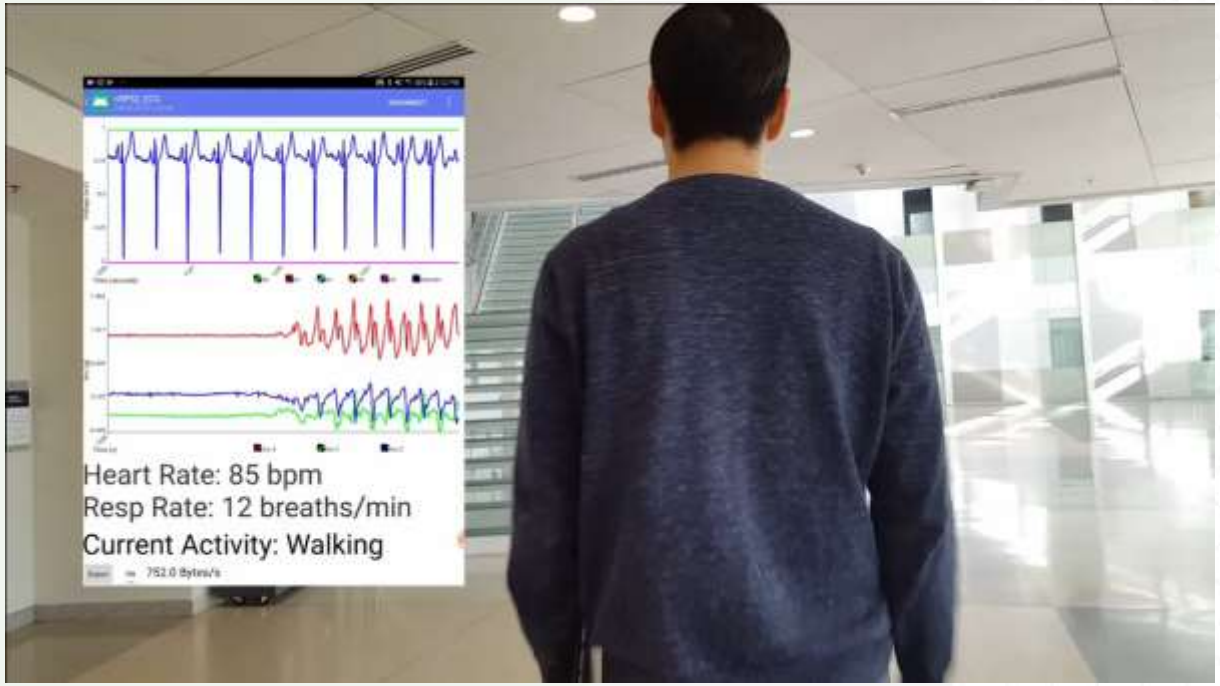


BioRadio (commercial)



BioStamp (commercial)

ADVANCES IN AMBULATORY ECG



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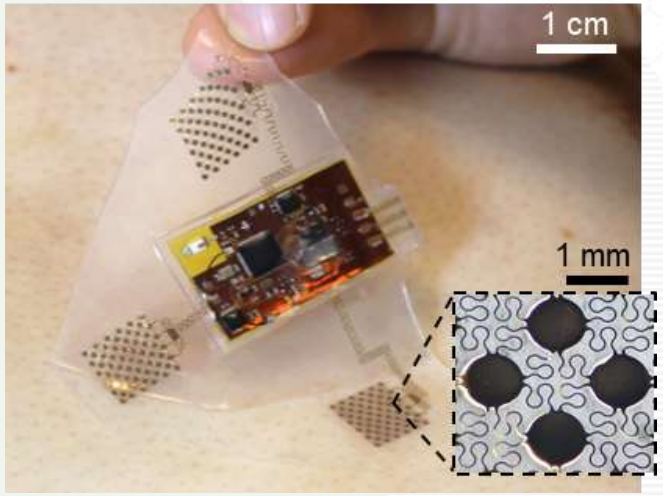
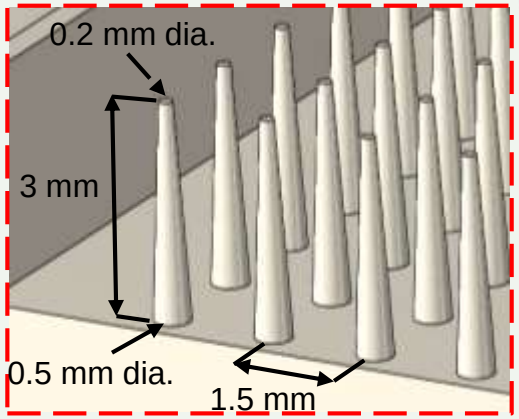
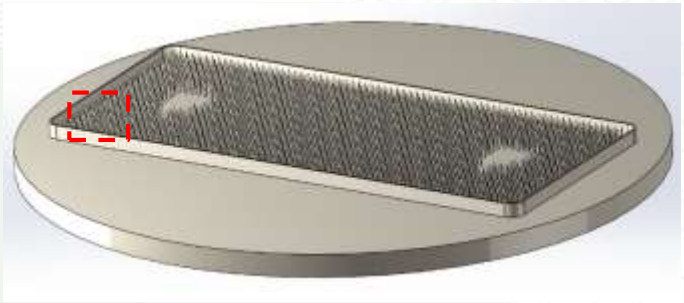


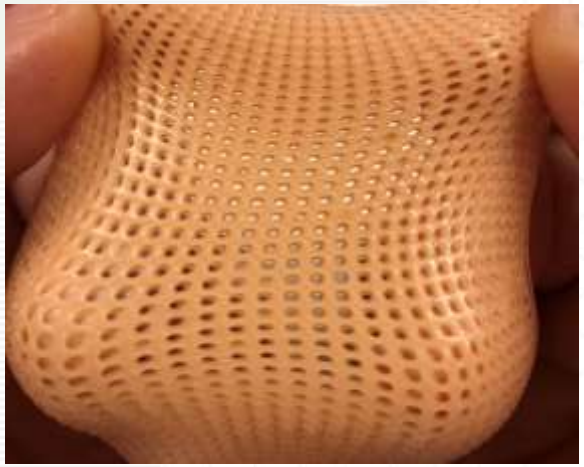
- High power consumption
- (heavy device)
- Large device footprint
- Not breathable

- Lower power consumption
- Weight reduction
- Smaller footprint and profile
- Breathable
- Strain-isolating

KEY ENABLING FEATURES

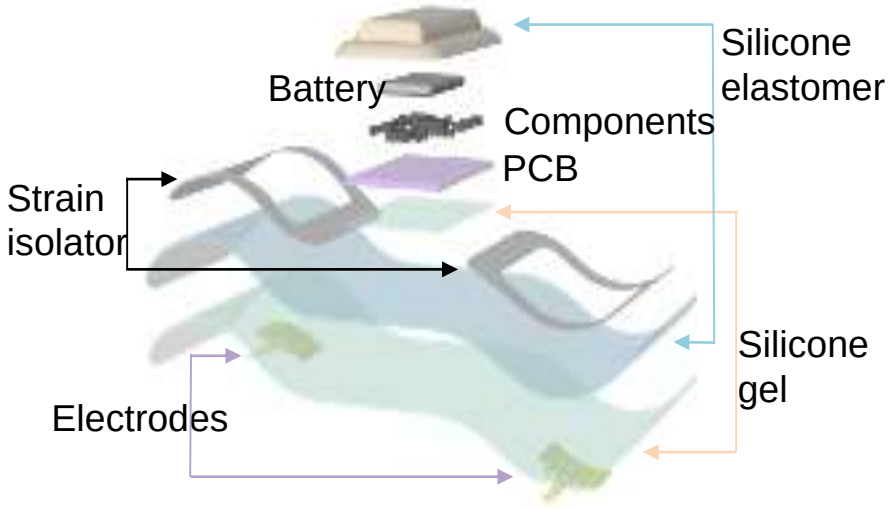






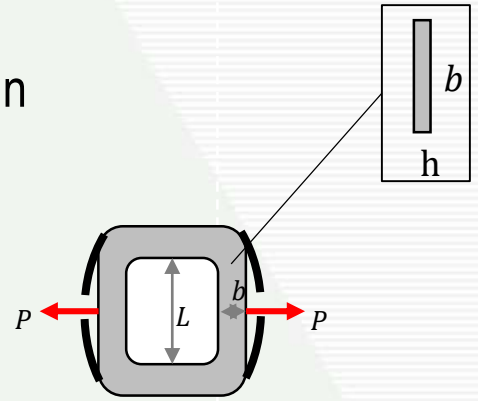
Ecoflex 30

Silbione

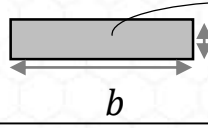


KEY ENABLING FEATURES

- Resist in-plane strain



Beam cross section

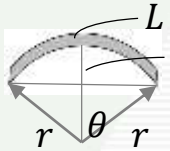


$$I = \frac{bh^3}{12}$$

$$\delta_{max} = \frac{PL^3}{48EI}$$

$$h_{min} = \frac{PL}{2Eb^3\delta_{max}}$$

- Remain flexible out-of-plane

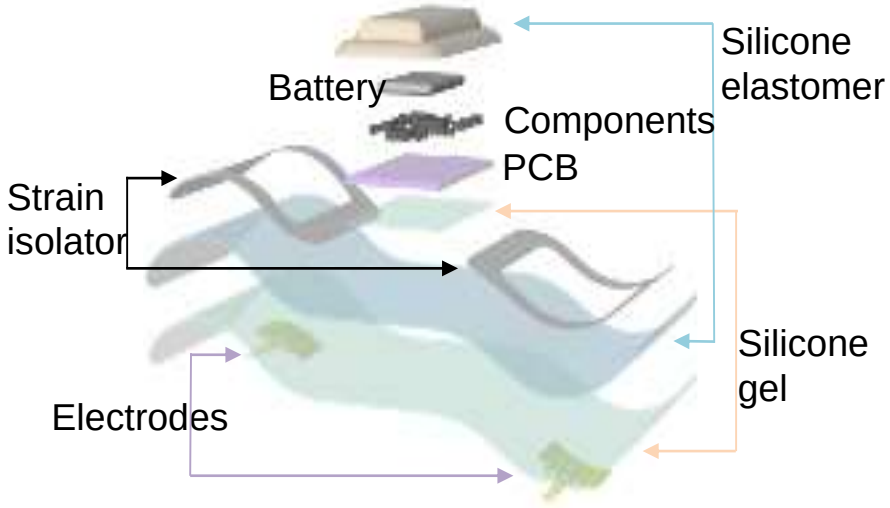


$$L = 2r\theta$$

$$\delta_{max} = r - r\cos\theta$$

$$\delta_{max} = \frac{5qL^4}{384EI}$$

$$h_{max} = \sqrt[3]{\frac{5qL^4}{32Ebr\left[1 - \cos\left(L/2r\right)\right]}}$$



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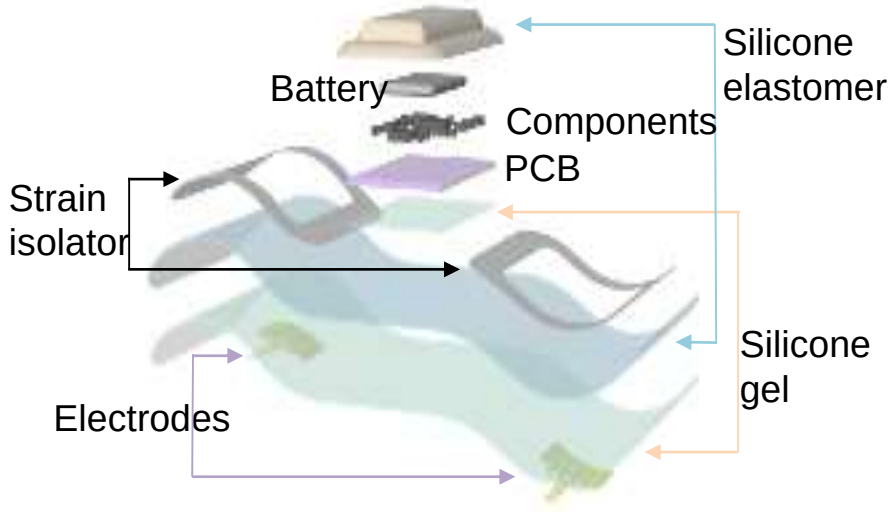

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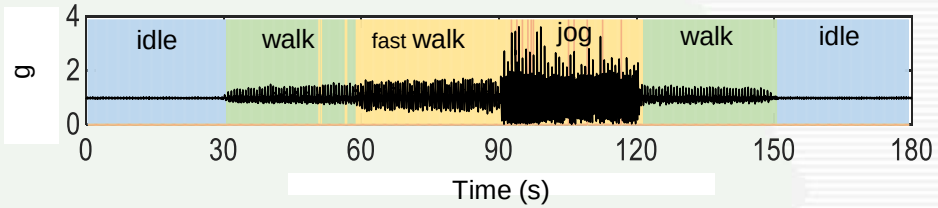
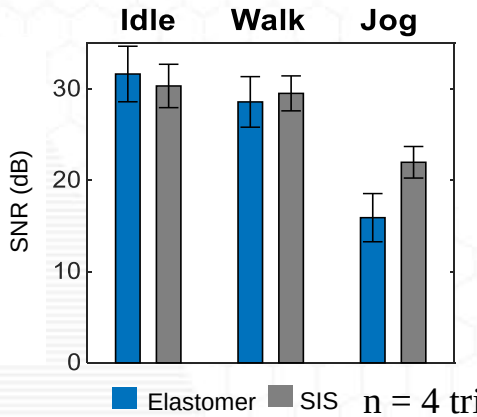
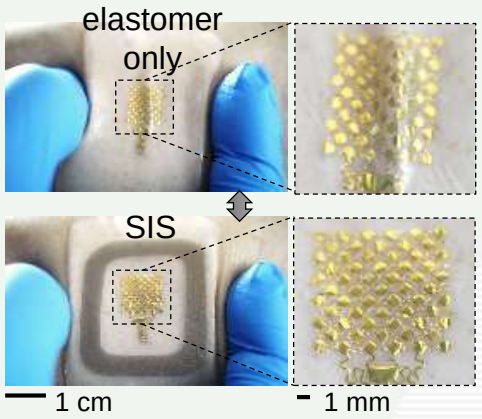
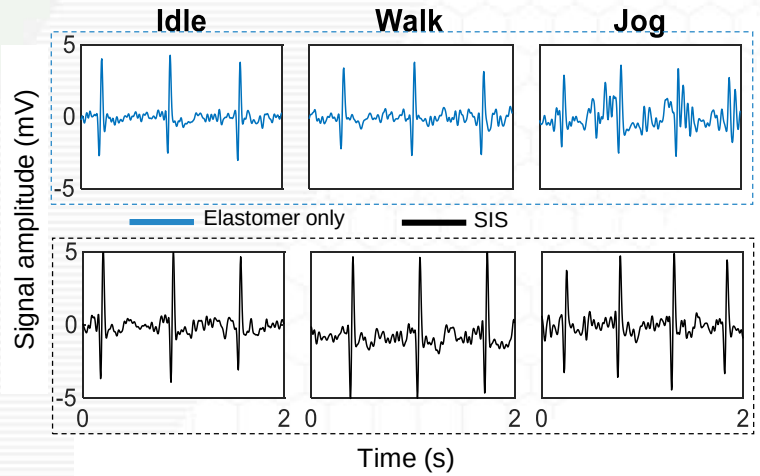
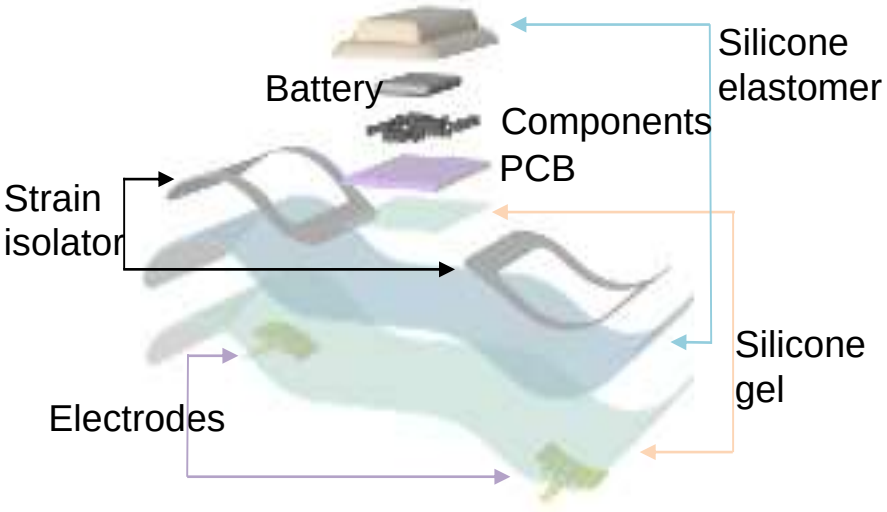




n = 4 trials







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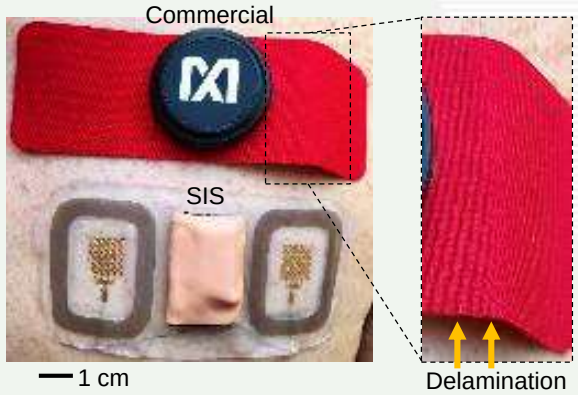
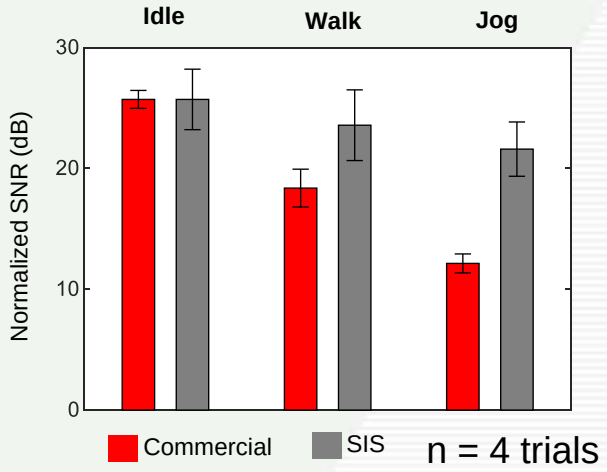
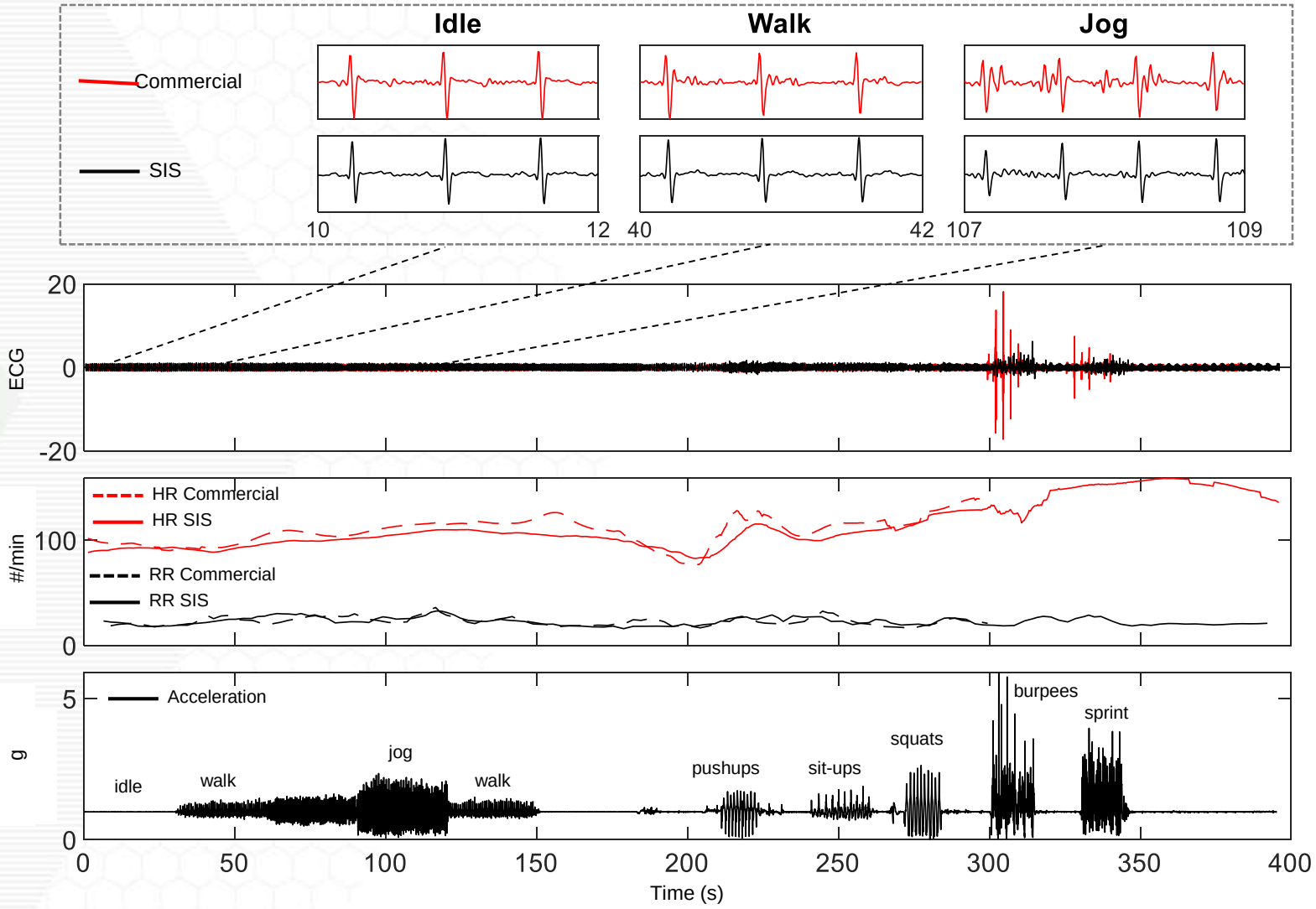
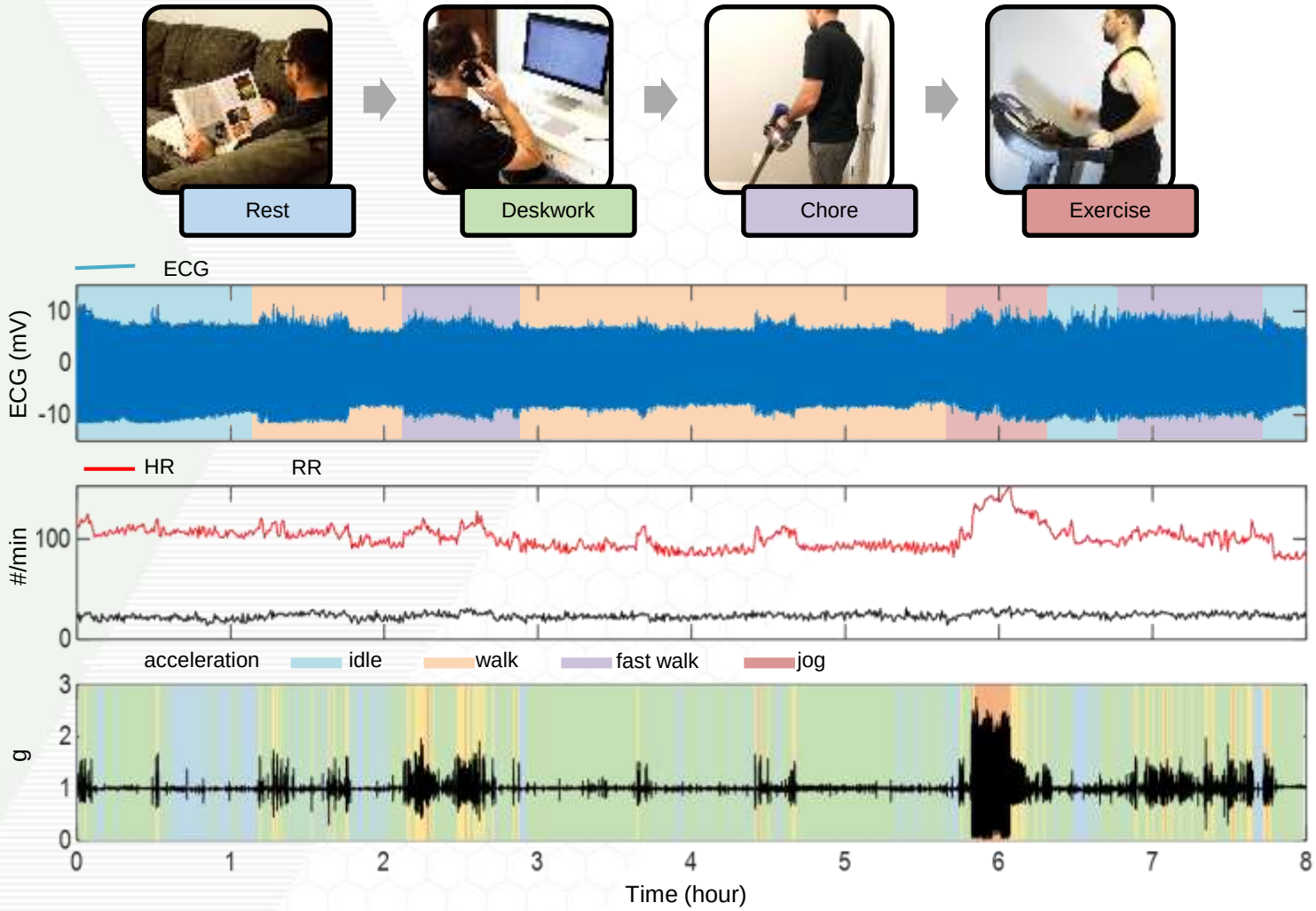






REAL-TIME ALL-DAY MONITORING

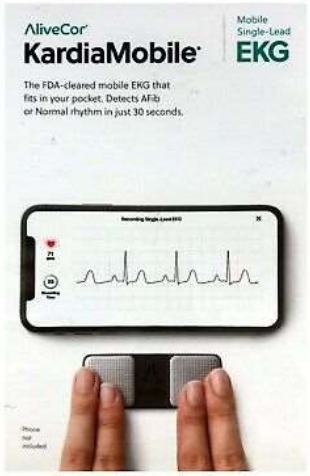


SUMMARY

Traditional

1

Today



2

Next Generation

ACKNOWLEDGMENT

Bio-Interfaced Translational Nanoengineering Group
PI: Professor Woon-Hong Yeo

Thank You!

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  - **Email: ysk@me.gatech.edu**
  - **Website: www.ysk.bio**
- **Yeo Research Group**
  - **Website: yeolab.gatech.edu/**