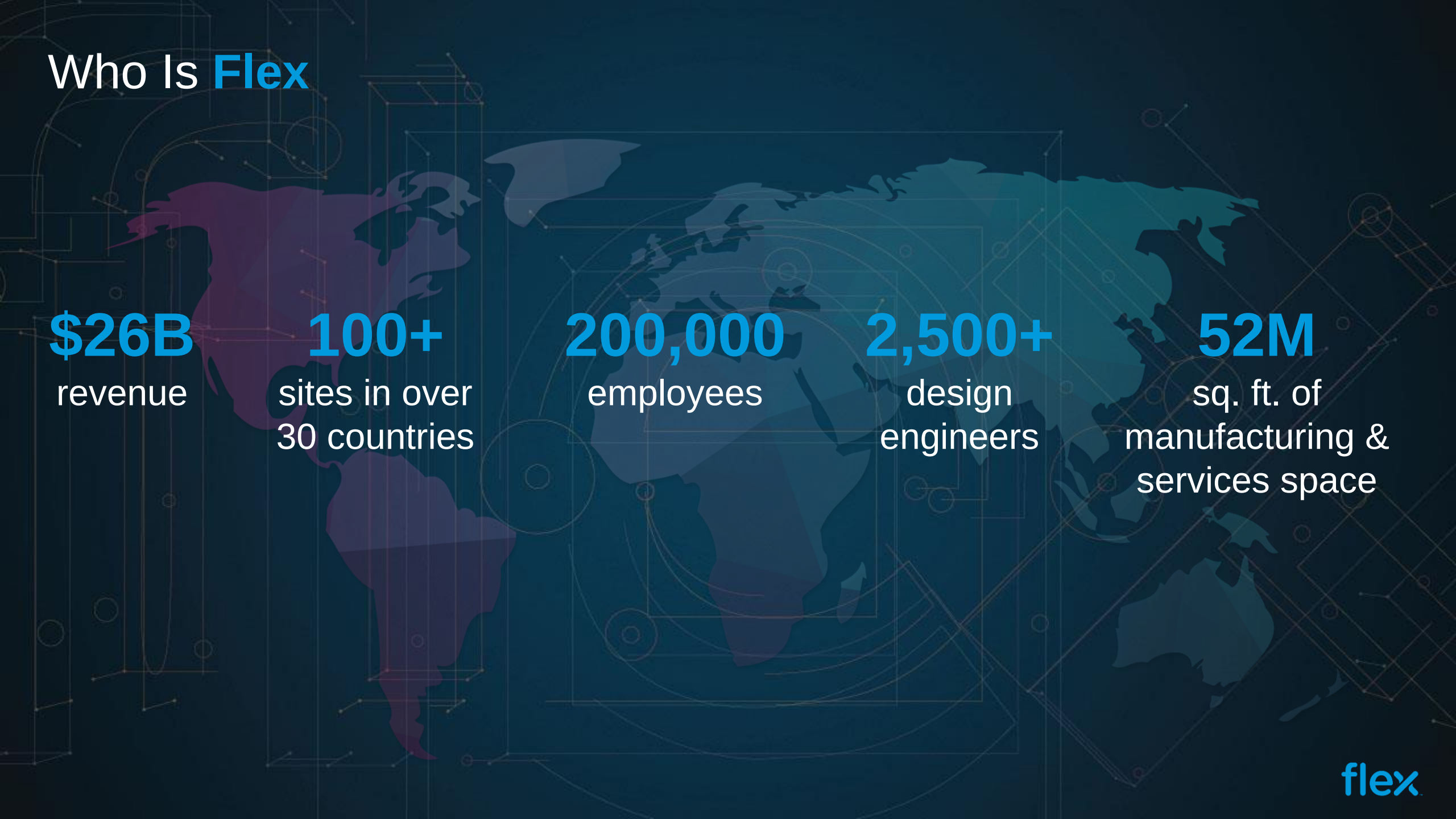
Flexible Biometric Sensor and Low-cost MEMS Devices

Cihan Yilmaz, PhD

Flex Boston Innovation Center

Who Is Flex



$26B
revenue

100+
sites in over 30 countries

200,000
employees

2,500+
design engineers

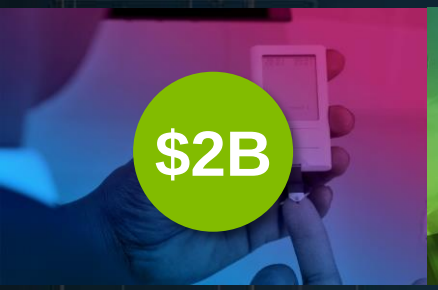
52M
sq. ft. of manufacturing & services space

Global Design & Innovation **Presence**

5 Innovation Centers | 9 Product Introduction Centers | 25+ Design Centers | 2900 Design Engineers

Insight across **industries**

Revenue



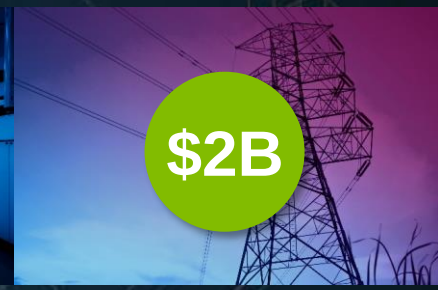
Medical

Automotive

Industrial

Home Appliances

Capital Equipment



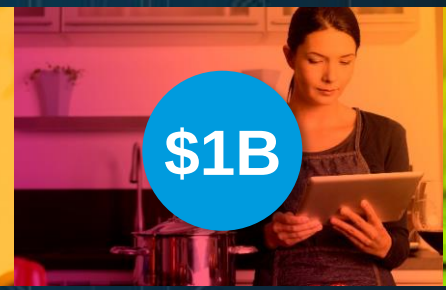
Energy

Telecom

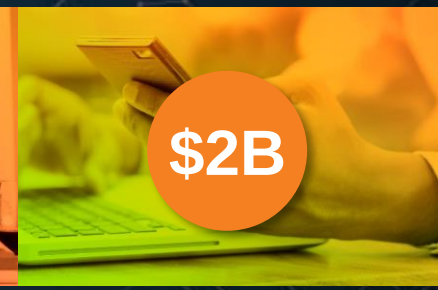
Networking

Enterprise Compute

Health & Fitness



Connected Living



Mobile

Collective **Innovation**

Access to new & tested technology building blocks

Development partner ecosystem

Improved product reliability

Accelerate time to market

Early stage engagement

Entry into new & adjacent markets

Experienced design & engineering teams

Flex Boston **Innovation Center**

Overview

A concepting, design & short run production facility to support the regional innovation economy from large multinational customers to startups.

Focus areas include

Health, Robotics, Textile & Apparel

Equipment includes

3D printers & modeling,
CNC machining (metal, plastic, foam)
High precision injection molding
Laser metal cutter
Textile Engineering

Space

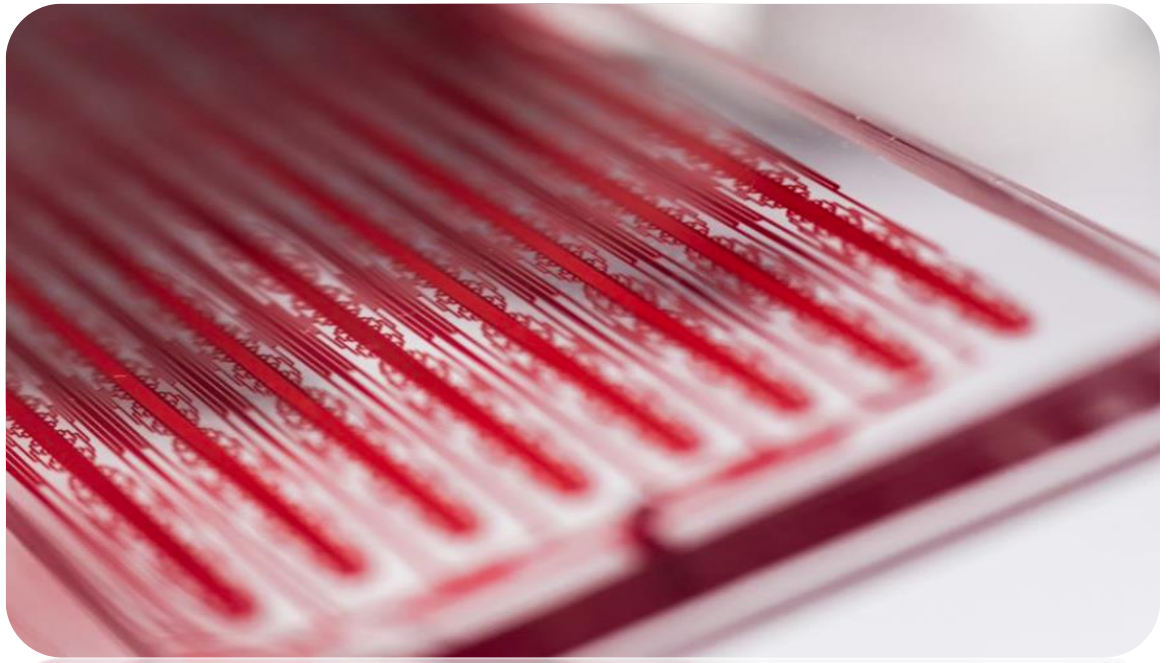
17,000 sq ft to support product & system design, prototyping, assembly and testing

Microfluidics

Microfluidics: Precise control and manipulation of fluids that are geometrically constrained to a small, typically sub-millimeter scale.

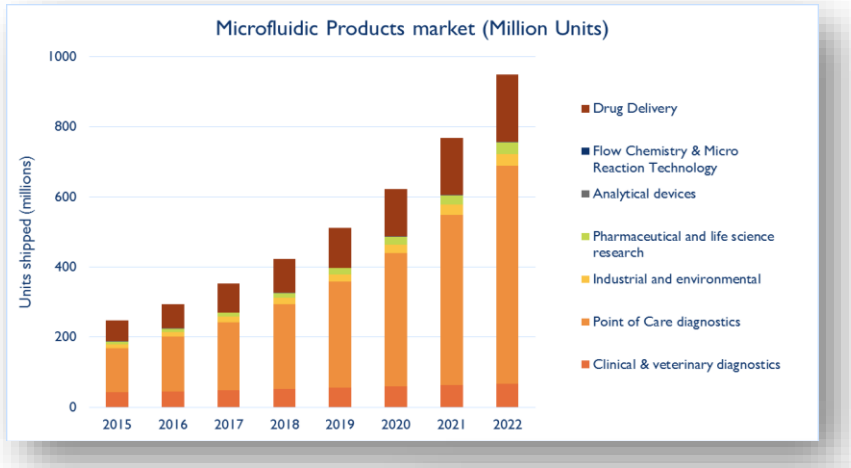
Advantages of Microfluidics:

- Use of miniscule amounts of samples and reagents in the lab
- Cost reduction due to lesser use of expensive reagents
- High resolution and sensitivity in the detection
- Reduced footprint of analytical and diagnostic systems
- Shorter analysis times and faster results
- Greater flow control



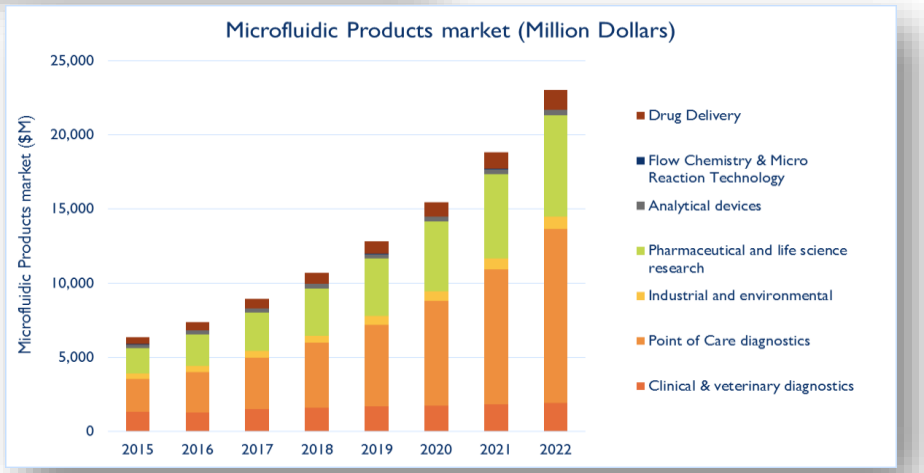
Microfluidics Market

Volume & Value



The number of microfluidic-based products in will reach

400M to 1B units in 2022.



The global microfluidic-based products market will more than triple by 2022 to reach

$23B

Source: Yole Development, Status of Microfluidics, May 2017

Flex play in the market?

- High volume manufacturing
- Low-cost
- Innovative designs
- Design for manufacturing

Flex Microfluidics Prototyping and Manufacturing Capabilities

3-D Printing

- Flexible and rigid substrates
- Digital ABS and Simulated Polypropylene
- 14 microns resolution
- Very fast, inexpensive

CNC Machining

- Flexible and rigid substrates
- Wide range of materials including biocompatible (PC, COP, COC etc.)
- 125 microns minimum feature size
- Robustness, suitable for low-volume prototyping

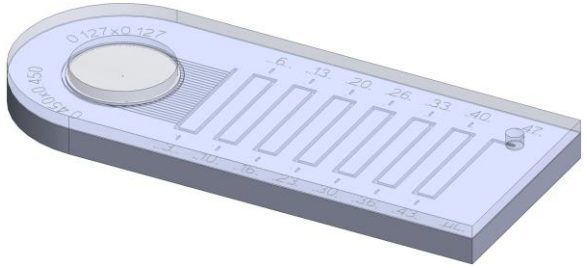
Precision Injection molding

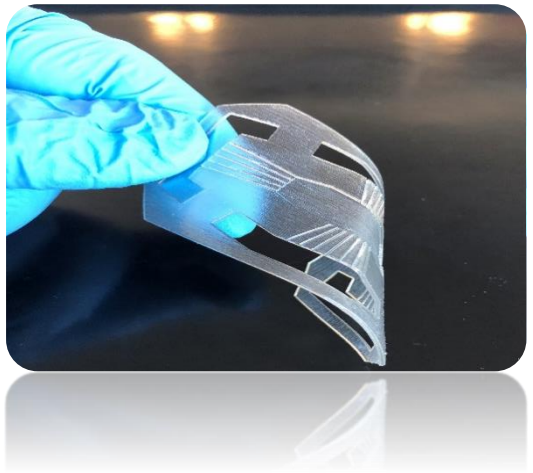
- Flexible and rigid substrates
- TPU, PC, PET, others
- 125 microns minimum feature size
- High-volume manufacturing

- ANSYS Enterprise – Mechanics and Fluidics Simulations

Microfluidics Applications

- Molecular Diagnostics (DNA, RNA, protein analysis)
- Point-of-care Diagnostics (Biomarkers, electrolytes, glucose, cell sorting)
- Advanced Wound Healing (Bandages)
- Digital Microfluidics (Nano-fluidics)





Sweat Sensing

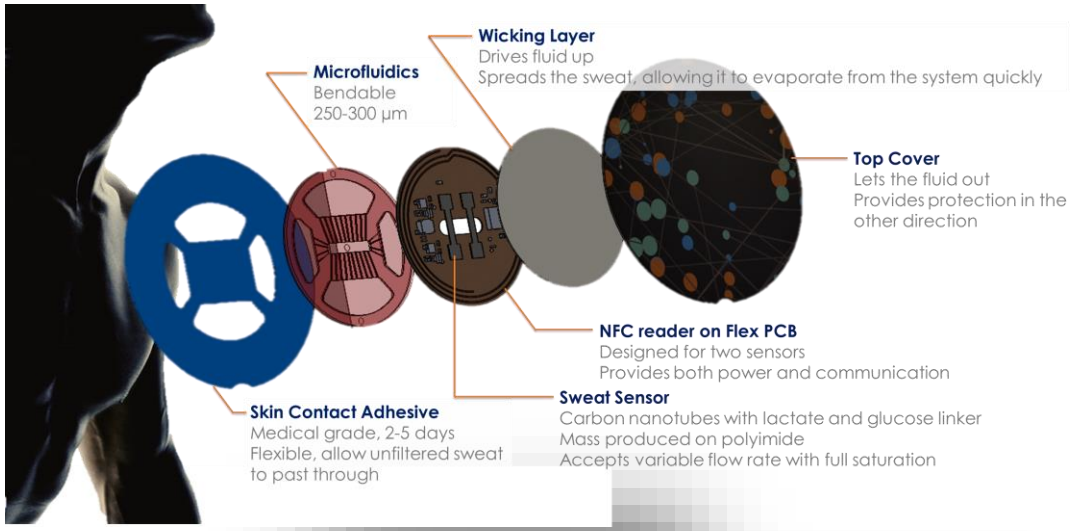
Photo: Getty Images

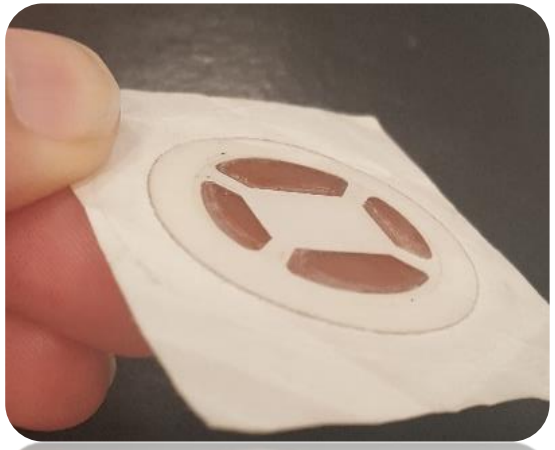
Why sweat?

- Noninvasive
- Rich with biometric information
- Glucose, lactate and electrolytes
- Drug Monitoring

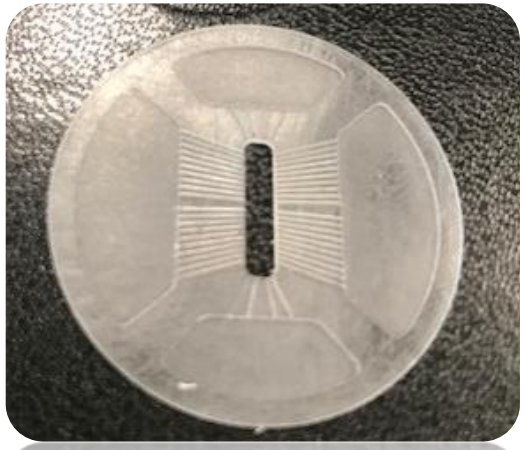
Sweat Patches for Biomarker Detection

- Biometric measurement (glucose, lactate and etc.)
- Noninvasive
- Instant results
- Multiple biomarker detection
- CNT and graphene integration

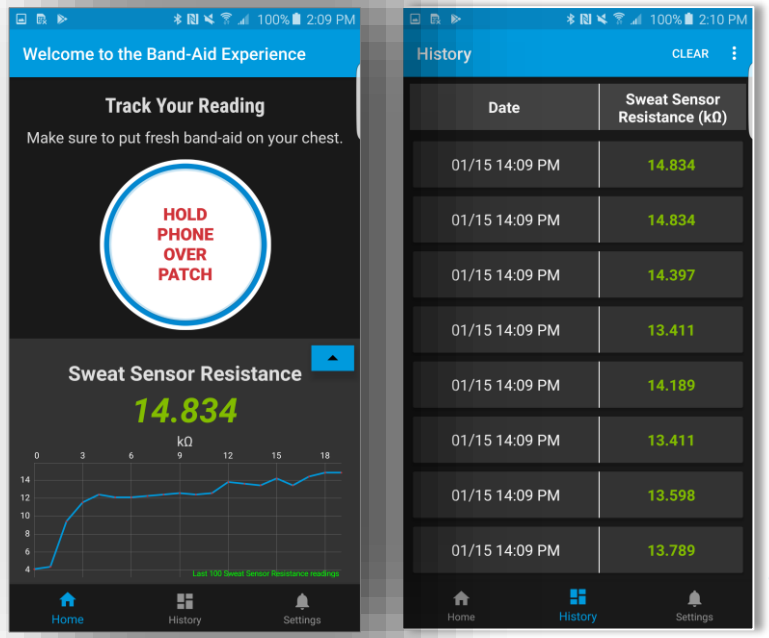




2.7 mm thick
1.85 x 1.85 inch



Microfluidics chip



Opportunity for Innovation in Ultrasonic Transducer Development

Global Market Growth

$1.49 Billion

Industry by 2024

17.7%

Average global CAGR during forecast period 2016-2024

Application Areas & Markets

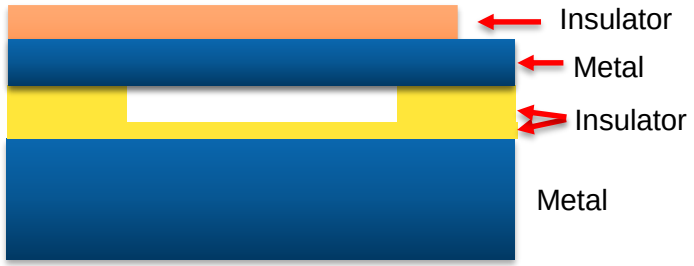
- Liquid level measurement
- Distance measurement
- Ultrasound microscopy
- Wireless power transfer
- Anti-collision detection
- Gesture recognition
- Object detection
- Medical imaging
- Flow metering

- Medical
- Oil & Gas
- Chemical
- Automotive
- Construction
- Material Handling
- Food & Beverages
- Aerospace & Defense

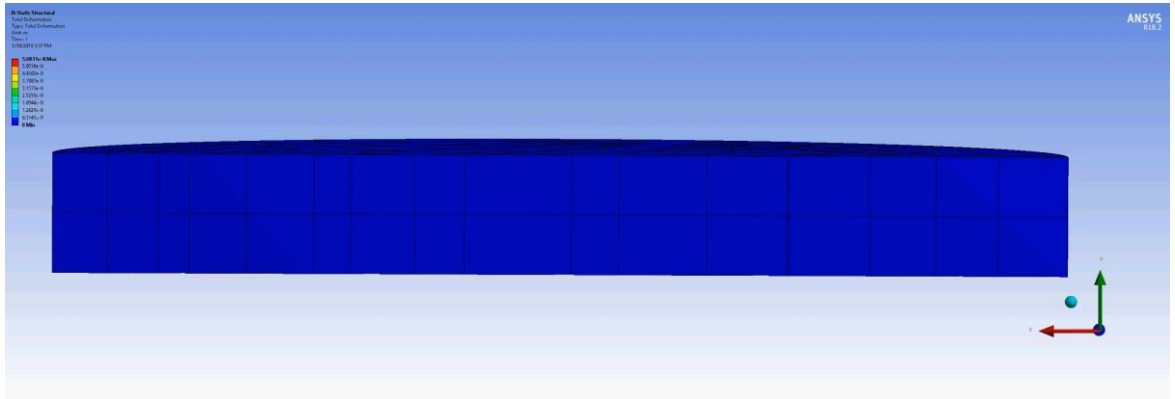
Low-cost Ultrasonic Transducer

- Made up of a base electrode whose position is fixed, a vacuum sealed cavity, an elastic membrane, and an upper electrode
- Signals are transmitted when the device is connected to an AC power source
  - The AC produces changing electrostatic forces between the two electrodes, and results in the upper electrode moving at a high frequency, which produces ultrasonic waves.
- Currently made using typical semiconductor-based fabrication techniques
- The goal is to create a polymer-membrane based CMUT that is ultimately much cheaper than semiconductor- based CMUTs
- We designed the gap height, membrane thickness, membrane radius, & materials to design a CMUT

Low Frequency Design

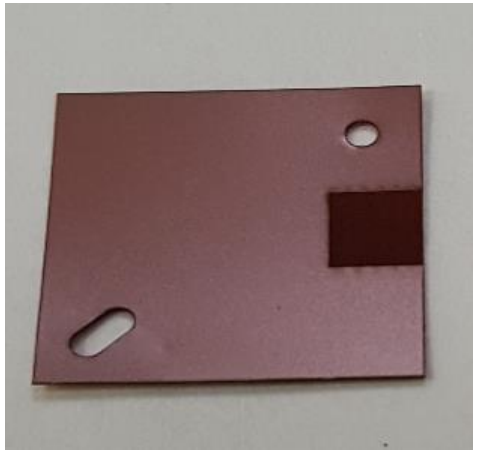


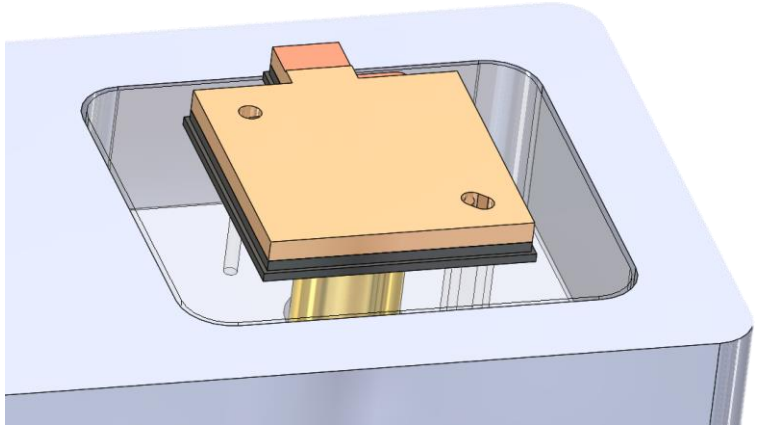
Ansys Simulation of High Freq. Design

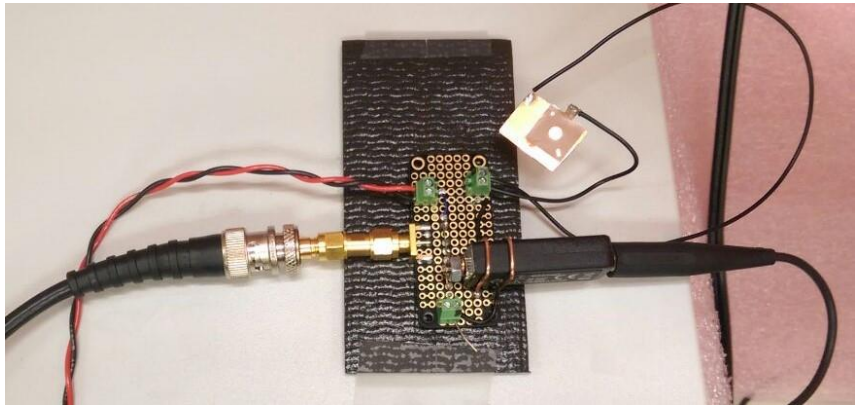


Material Processes

- Membrane cavity cut with M-Solv laser
  - Combines 2 lasers to provide a 266 nanometer UV beam
- Pyralux Ac (composite of polyimide with copper foil) to be cut with M-Solv







Thank You