

# Hydrogel Ionic Device

Current Status of Structural Materials

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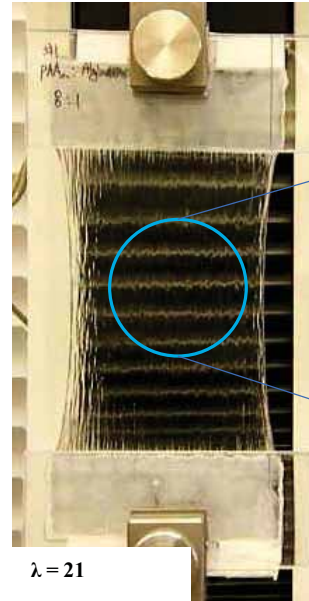
Dept. of Materials Science and Engineering

Seoul National Univeristy

# Stretchable ionic device

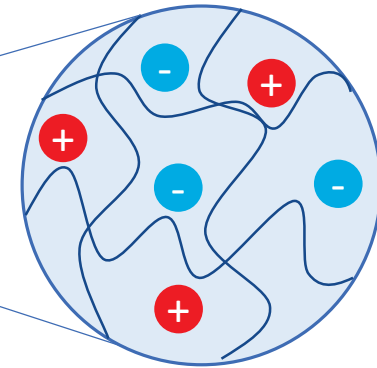


Medium.com



$\lambda = 21$

J.-Y. Sun, et al. *Nature*, (2012)

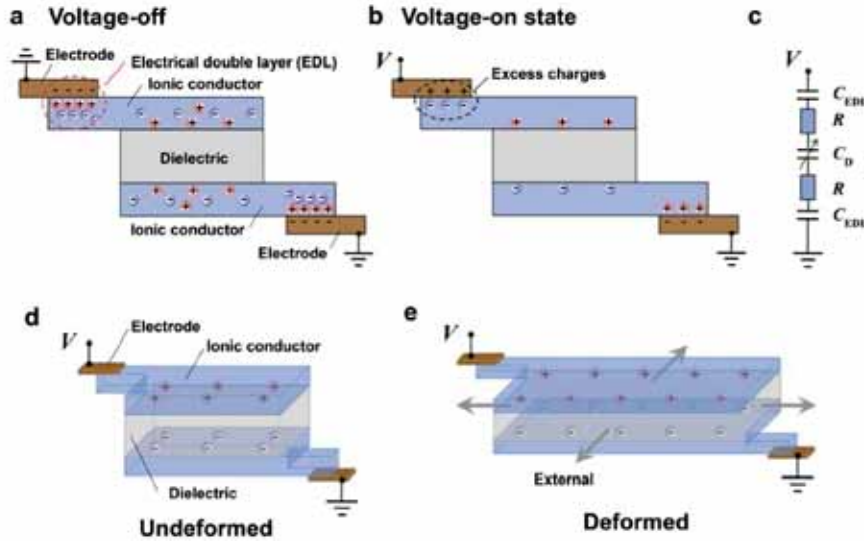


- Intrinsically stretchable
- Biocompatible
- Ionic currents is same signal carrier for biological areas

# Contents

1. Wearable sensors
  - Strain sensor
  - Pressure sensor
  - Touch panel
  - Communicator
  
2. Actuator
  - Dielectric elastomer actuator
  - Loud speaker

# Sensor

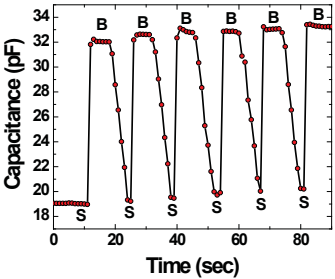


$$\frac{1}{C} = \frac{2}{C_{EDL}} + \frac{1}{C_D}$$

$$C_{EDL}/C_D \approx 10^5$$

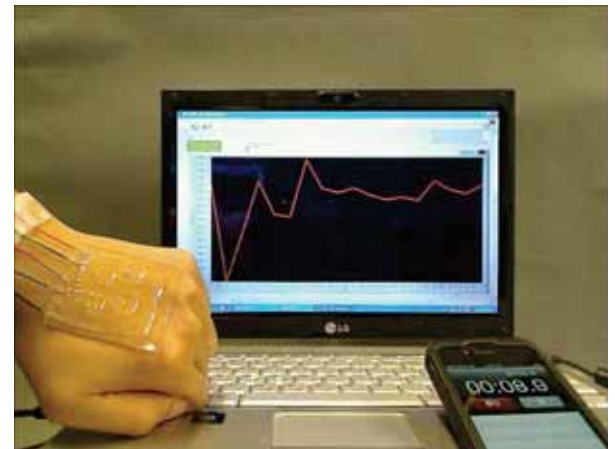
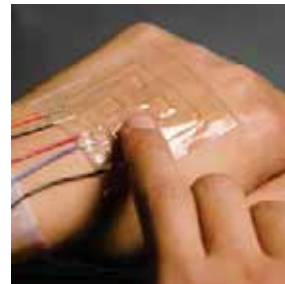
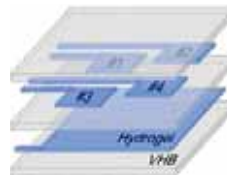
$$C \approx C_D \quad C_D \propto \frac{\epsilon A}{d}$$

## Transparent Strain Sensor



J.-Y. Sun et al. *Advanced Materials*, (2014)

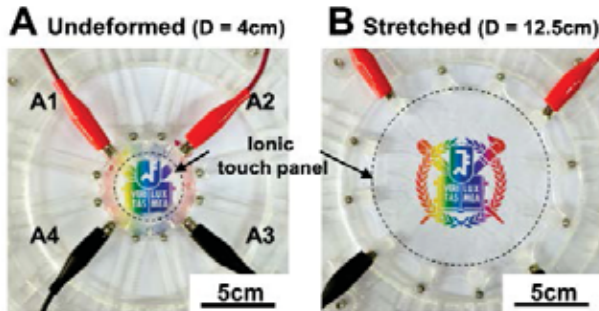
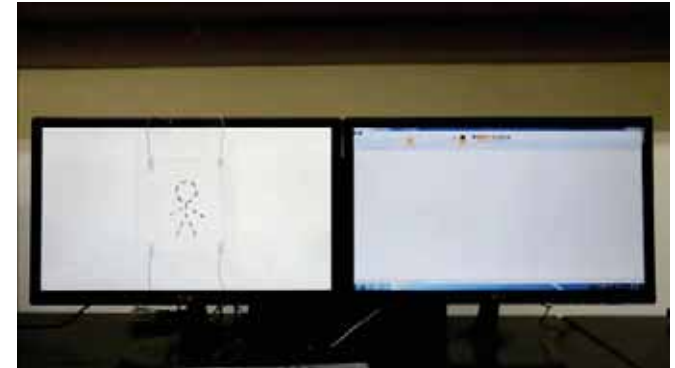
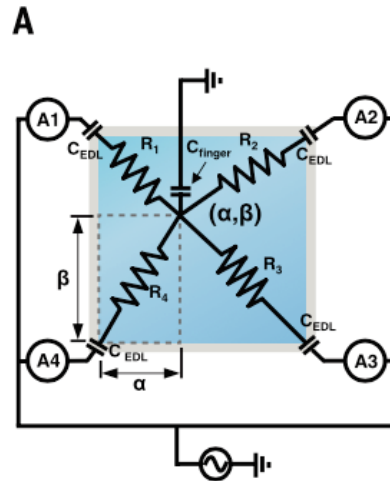
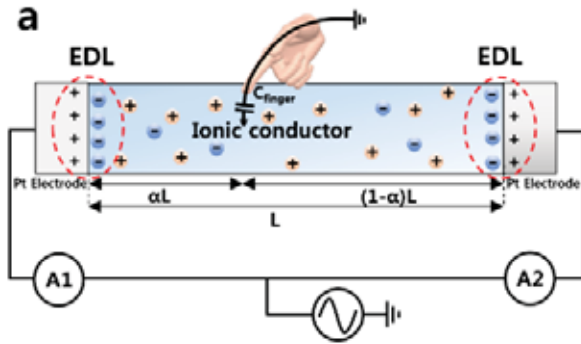
## Transparent Pressure Sensor



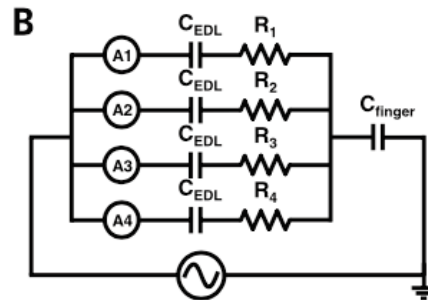
J.-Y. Sun et al. *Advanced Materials*, (2014)

# Touch panel

## ■ Ionic Touch Panel



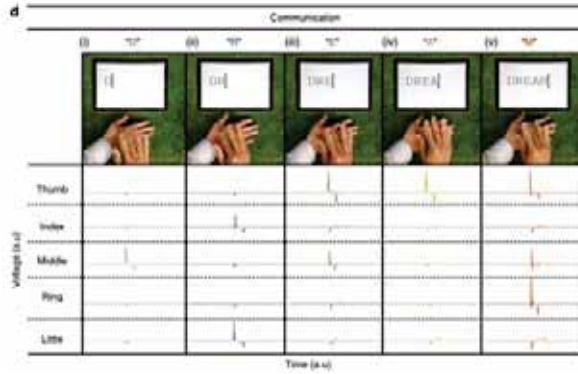
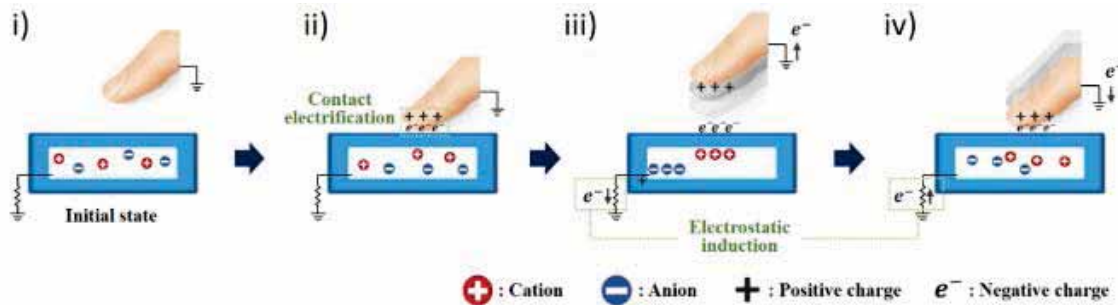
~ 1000 % Areal Strain



C.C. Kim et al. *Science* (2016)

# Ionic communicator

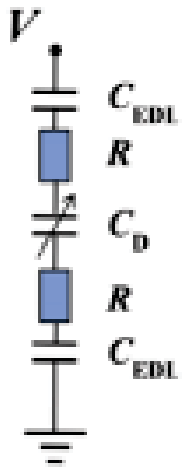
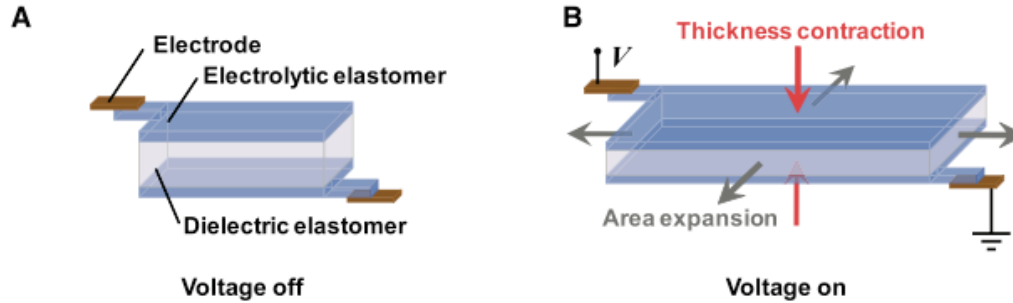
## Self Powered communicator based on Triboelectric nanogenerator



Y. Lee et al. *Nature Comm.* (2018)

# Actuators & Loud Speaker

## ■ Dielectric elastomer actuator



$$C_{EDL} \sim 10^{-1} \text{ F/m}^2$$

$$C_D \sim 10^{-8} \text{ F/m}^2$$

$$C_D A_D V_D = C_{EDL} A_{EDL} V_{EDL}$$

$$V_D \sim 10 \text{ kV}$$

$$V_{EDL} \sim \textit{below 1 V}$$



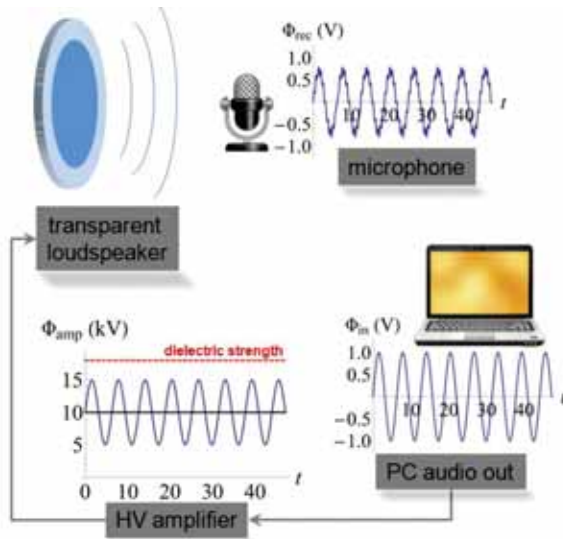
**No electrochemical reaction**

**A beating heart at 1 Hz**



# Actuators & Loud Speaker

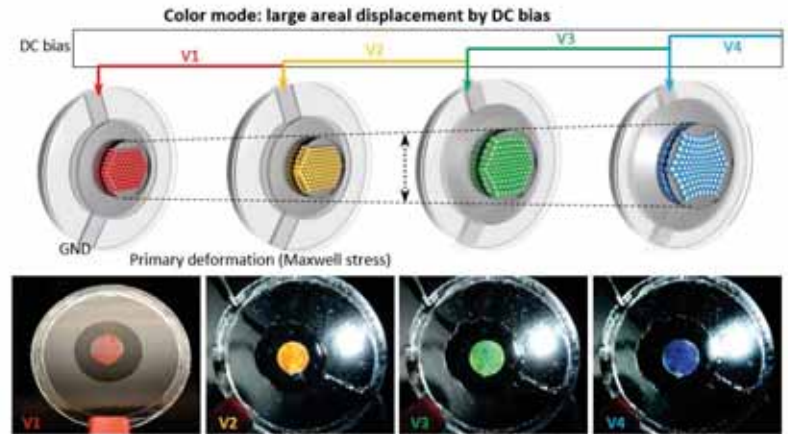
## ■ Transparent loudspeaker



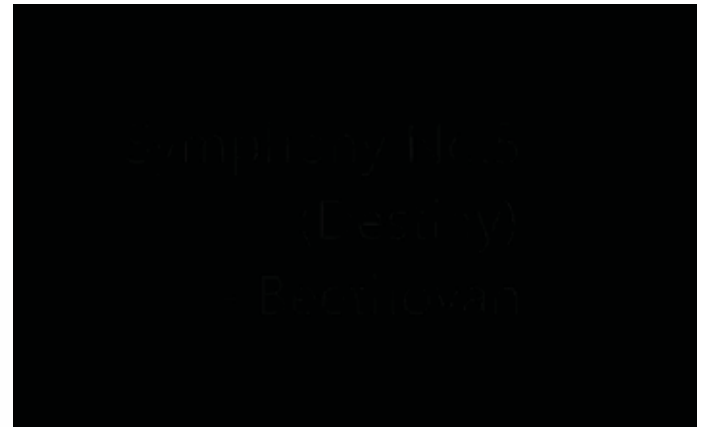
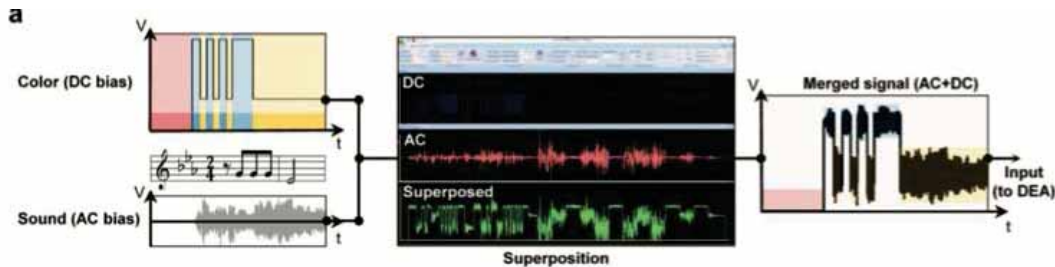
working with 10 kV (**no reaction**)  
and 20 kHz (**fast**)



# Electro-active soft photonic skins



## Active color mode

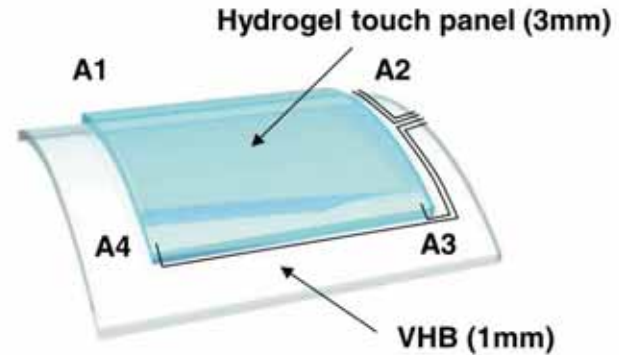


# Summary

## 1. Strain & Pressure sensor



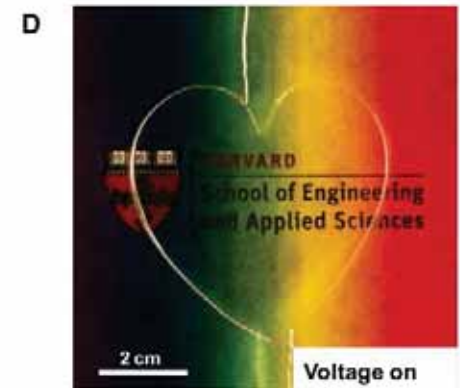
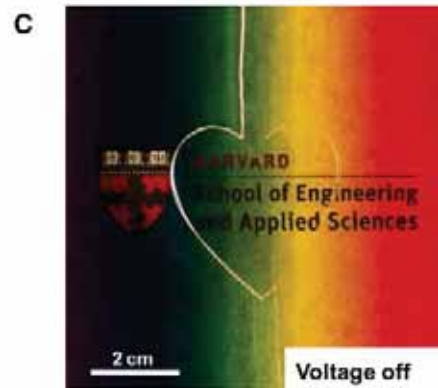
## 2. Touch panel



## 3. Ionic communicator



## 4. Actuator



Thanks for listening