**Vision: Smart and Connected Health**

To make low-cost high-performance self-powered disposable sensors for smart and connected health

- **What in inconspicuous them of**
- **Red)**
- **Nanowatt**
- **Galvanic electrochemical sensor to**
- **Sub**
- **or**
- **dispose**
- **false**
- **like**
- **die**
- **and**
- **nanomaterials**
- **for**
- **false**
- **graphene**
- **Physical**
- **itself**
- **CMOS**
- **signal**
- **electronics**
- \[ + 2H \]
- **Distributed layout for higher output impedance**
- **piezoelectric**
- **that**
- **Two pieces of paper for four layer**
- **on**
- **voltage**
- **disposable?**
- **EEG)**,
- **Planar geometry**
- **= we (~**
- **textile**
- **power**
- **which**
- **Printed**
- **Negative impedance source degeneration**
- **transistor**
- **Double**
- **paper**
- **and**
- **Gases,**
- **Filter paper saturated with KOH**
- **–**
- **Low**
- **circuit**
- **to**
- **Sensors**
- **Physical**
- **(right,**
- **on**
- **Activity**
- **T**
- **easy**
- **circuits**
- **Pt Nanowires on paper**
- \[ + 2H \]
- **biopotentials)**
- **do**
- **compounds,**
- **continuous)**
- **are**
- **environment**
- **friendly**
- **Recording**
- **power**
- **Ease**
- **Biopotentials**
- **CMOS**
- **the**
- **You**
- **of**
- **substrates**
- **nanotubes**
- \[ + 2H \]
- **and**
- **substrates**
- **aluminum**
- **copper**
- **in**
- **current**
- **input**
- **input source degeneration**
- **transistor**
- **Double sided double paper**
- **Paper**
- **Silver**
- **Tape**
- **Zinc**
- **Filter paper saturated with KOH**
- **PDMS**
- **membrane is**
- **attached.**
- **Oxidation at Zn anode:**
- \[ 22n + 22OH^- + 4e^- \]
- **Reduction at Ag cathode:**
- \[ O_2 + 2H_2O + 4e^- \]
- **Overall reaction:**
- \[ O_2 + 2H_2O + 22n \]
- **PDMS**
- **Double-sided tape**
- **Zinc**
- **Paper**
- **Silver**
- **Tape**
- **Filter paper saturated with KOH**
- Electrodes, Sensors, Batteries, Electronics can all be built on paper using low cost approaches in resource-poor settings with applications in healthcare and environment

**Topic 3: Disposable Printed Circuit Boards**

- **Disposable paper based oxygen (and other electrochemical) sensor**
- **Two pieces of paper for four layer PCB all on paper**
- **Screen printing for interconnects**
- **and punching for via**
- **Galvanic electrochemical sensor to measure oxygen**

**Fabrication Process**

1. Tape was patterned
2. Patterned tape is attached.
3. Silver ink is spin coated and cured.
4. Tape was peeled off.
5. Saturated filter paper is attached using double-sided tape.
6. PDMS membrane is attached.

**Oxygen Sensor Structure**

**Front side**

- **Zinc is electroplated on one of the electrodes.**
- **PDMS**
- **Filter Paper**
- **Saturated with KOH**
- **Silver**
- **Paper**
- **Tape**

**Back side**

- **Oxidation at Zn anode:**
- \[ 22n + 22OH^- + 4e^- \]
- **Reduction at Ag cathode:**
- \[ O_2 + 2H_2O + 4e^- \]
- **Overall reaction:**
- \[ O_2 + 2H_2O + 22n \]

**Electrodes, Sensors, Batteries, Electronics can all be built on paper using low cost approaches in resource-poor settings with applications in healthcare and environment**

**Topic 4: 0.25V Amplifier and Analog to Digital Converter**

**0.25V 18nW 60dB OTA**

- **Bulk-driven input stage**
- **Sub-threshold operation**
- **Distributed layout for higher output impedance**
- **Negative impedance source degeneration**

**0.25V Async Delta Sigma Modulator**

- **Single bit First order ADSM Architecture**
- **0.25V Comparator**

**Transistor**

- **Power supply:** 0.25 V
- **Technology:** 150 nm
- **Transconductance:** 2.8 nS
- **Gain:** 9.3 V/mA
- **Minimum input current:** < 3 nA
- **Open loop gain:** 40 dB
- **Unity gain frequency:** 18.6 kHz
- **Phase margin:** 72.5°
- **Gain-bandwidth:** 0.26 V/μA
- **Input referred thermal noise:** 0.57 nV/√Hz
- **Offset voltage standard deviation:** 2.7 nV
- **Power consumption:** 18 nW
- **OTA area:** 0.083 mm²
- **PVT tolerance:** ±3% to ±7%