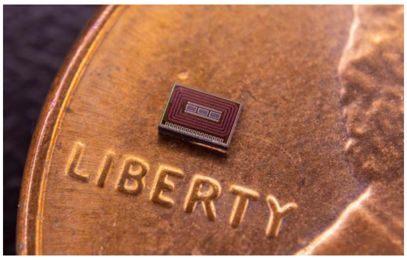
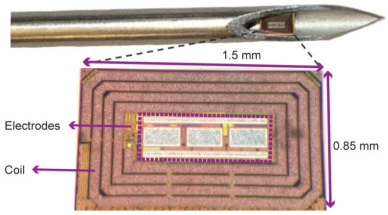
Implantable alcohol-monitoring chip communicates through RF backscatter

April 12, 2018 // By Julien Happich



In a paper titled "A Sub-1 µW Multiparameter Injectable BioMote for Continuous Alcohol Monitoring" presented at the Custom Integrated Circuits Conference (CICC) in San Diego, researchers from the University of California San Diego shared the details about an ultra-low power implantable biosensor.

Sporting an array of microelectrode electrochemical sensors designed to measure ethanol levels, combined with a 4-turn on-chip coil for RF energy harvesting and backscatter communication, the 0.85×1.5mm^2 chip is small enough to be injected under the skin using a 16-gauge syringe for continuous, long-term alcohol monitoring.

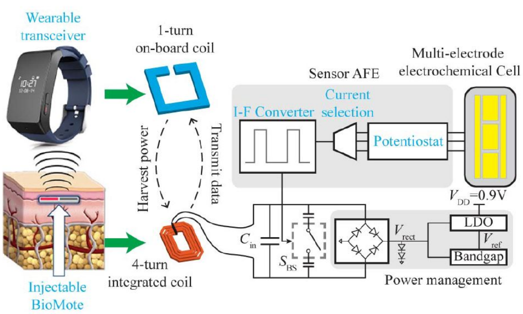


Close up photograph of the CMOS die.

In order to remove ambient interferences and motion artifacts, the "BioMote" sensor node as the authors describe it consists of three electrochemical sensors: one functionalized with the AO_x enzyme to measure ethanol; one unfunctionalized sensor that measures background and non-specific/interfering species; and a third microelectrode functionalized with a hydrogen ion selective membrane (IrO_x), to perform pH measurements. This allows for a differential measure of the ethanol content in the subcutaneously interstitial fluid.

The alcohol monitoring chip alongside a penny and a 16 gauge needle. Photos by David Baillot/ UC San Diego Jacobs School of Engineering.

The sensing principle is based on the enzymatic reaction that occurs when alcohol oxidase (AOx) interacts with ethanol, producing hydrogen peroxide (H_2O_2) as a by-product which is then oxidized to generate free electrons to be detected. The researchers also implemented on-chip a low-power multi-technique potentiostat to support both amperometric and potentiometric measurements with 2.5nA sensitivity with 30.1 dB dynamic range and 0.5mV sensitivity with 43 dB dynamic range, respectively.



Architecture and communication principle of the BioMote sensor.

Designed in 65nm CMOS, the whole chip only draws 0.970µW and is powered via the coupling between its on-chip coil and a wearable device at 985MHz. It transmit the ethanol measurement readouts through backscatter using a self-oscillating current-to-frequency (I-to-F) converter, modulating the resonant frequency of the wireless link. The researchers also designed ultra-low power sensor readout circuits for the chip and were able to minimize its measurement time to just three seconds, further reducing power consumption.

1 2 next