Smart Nano-Structured Titania based MEMS Multi Gas Sensor for High Temperature and Harsh Fossil Environment Application

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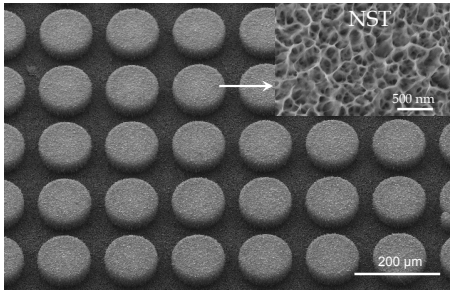
Novelty

(1) Multi Sensors: 64 vs. 1 single sensor in ONE platform

(2) MEMS Sensor: Leverage *unique* Ti based MEMS Technology:

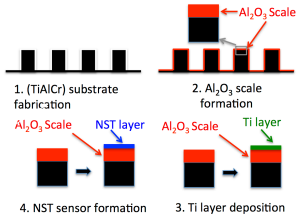
Nano Structured-Titania Sensing Platform
Increased the absorption surface by
x 2500/mm^2



(3) Sensitivity: Extremely sensitive with a shorter response time compared to any existing sensor technologies

(4) Gas Selectivity : Capable to detect accurately a specific target gas in a mixed gases environment

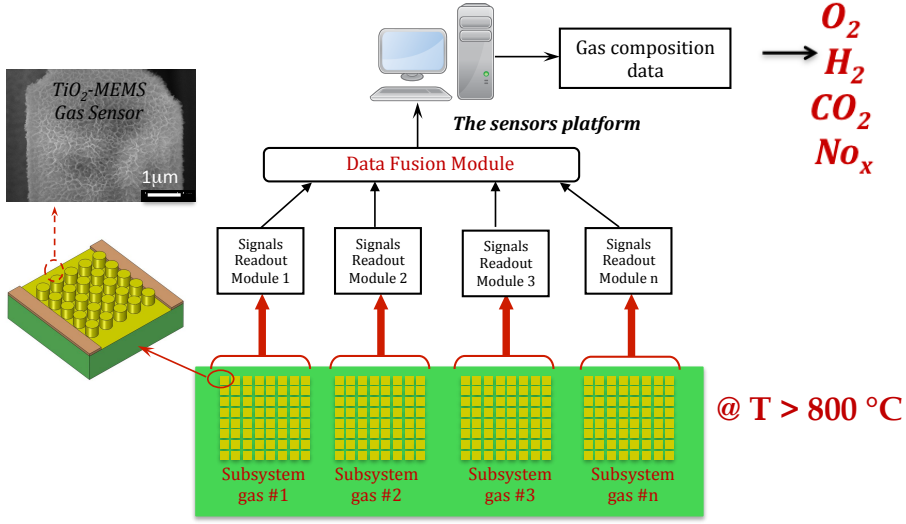
(5) New Material: Oxidation resistance alloy that withstands 1200 °C operating temperature and 1000 psi pressure.



(6) Leverage Data Fusion: to post-process the collected data resulting a **reliable** output signals

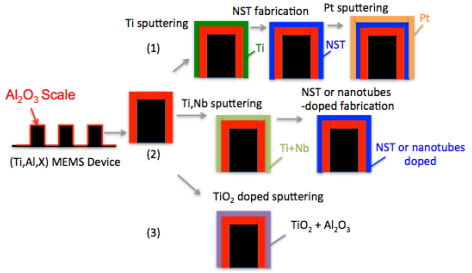
(7) Extremely Robust

MEMS Sensor Concept



Future Work (Phase II)

(1) Develop the Sensor Selectivity:
Will incorporate into the sensing layer metallic (Al, Cr, Nb) or metal-oxide (Al_2O_3, Y_2O_3) dopants, or deposit a thin layer of noble metal (Pt, Pd)

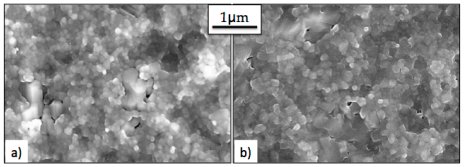


(2) Develop the Data Fusion Algorithm :
Will develop multivariate Principal Component Analysis (PCA) and Partial Least Squares Algorithms to post-processing 320 collected signals from each 64 individual sensor (5 sensors in one platform)

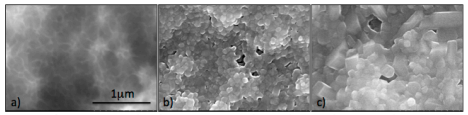
(3) Design, Fabricate and Test the Prototype Sensor:
Will implement PiMEMS's patented fabrication processes to design and fabricated the Ti-based MEMS Gas Sensor and will test the fabricated prototype at NETL/PiMEMS facilities.

Phase I Achievements

(1) Developed a New Material
Successfully integrated Nano-structured Titania (NST) thin film as the sensing platform to oxidation-resistant TiAlCrY and FeCrAlY coatings

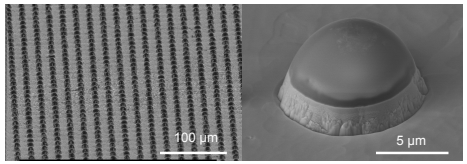


SEM surface micrographs showing an NST layer deposited on a pre-oxidized FeCrAl coupons, annealed at 800ºC, a) for 1h, b) for 15h

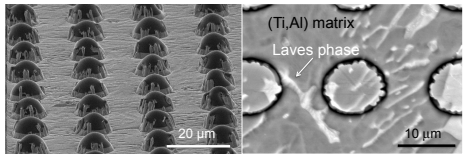


SEM surface micrographs showing an NST layer deposited on a TiAlCr-coated Ti coupon pre-oxidized at 800ºC for 1h. a) as fabricated NST layer, b) annealed at 800ºC for 1h, c) annealed at 800ºC for 15h

(2) Successfully developed an etching process to fabricate the micro pillars sensing platform on the developed alloy: 46-5Ti-37Al-17Cr-0.1Y



The developed process is scalable and enables to control the shape of the etched pillars



Micrographs of the pillars, 10um in diameter, 5 um in height formed by etching at the surface of a TiCrAl coupons, a) well distributed arrays of pillars, b) back scattered SEM image showing the bi-phase structure of the TiAlCr alloy and well defined pillars