



## Butrus Khuri-Yakub

Professor (Research) of Electrical Engineering, Emeritus

 Curriculum Vitae available Online

### Bio

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#### BIO

Butrus (Pierre) T. Khuri-Yakub is a Professor of Electrical Engineering at Stanford University. He received the BS degree from the American University of Beirut, the MS degree from Dartmouth College, and the Ph.D. degree from Stanford University, all in electrical engineering. His current research interests include medical ultrasound imaging and therapy, ultrasound neuro-stimulation, chemical/biological sensors, gas flow and energy flow sensing, micromachined ultrasonic transducers, and ultrasonic fluid ejectors. He has authored over 600 publications and has been principal inventor or co-inventor of 107 US and international issued patents. He was awarded the Medal of the City of Bordeaux in 1983 for his contributions to Nondestructive Evaluation, the Distinguished Advisor Award of the School of Engineering at Stanford University in 1987, the Distinguished Lecturer Award of the IEEE UFFC society in 1999, a Stanford University Outstanding Inventor Award in 2004, Distinguished Alumnus Award of the School of Engineering of the American University of Beirut in 2005, Stanford Biodesign Certificate of Appreciation for commitment to educate, mentor and inspire Biodesign Fellows, 2011, and 2011 recipient of IEEE Rayleigh award.

#### ACADEMIC APPOINTMENTS

- Professor Emeritus, Electrical Engineering
- Member, Bio-X
- Member, Cardiovascular Institute
- Member, Stanford Cancer Institute
- Member, Wu Tsai Neurosciences Institute

#### HONORS AND AWARDS

- Rayleigh Award, IEEE (2011)
- Certificate of Appreciation for commitment to educate, mentor and inspire, Stanford Biodesign (2011)
- Distinguished Alumnus, American University of Beirut (2005)
- Outstanding Inventor, Stanford University (2004)
- Distinguished Lecturer, UFFC Group of IEEE (1999)
- Distinguished Engineering Advisor, Stanford University (1987)
- Award for Contributions to Nondestructive Testing, City of Bordeaux (1983)

#### PROGRAM AFFILIATIONS

- Stanford SystemX Alliance

#### PROFESSIONAL EDUCATION

- PhD, Stanford University (1975)

- MS, Dartmouth College (1972)
- BS, American University of Beirut (1970)

## LINKS

- <https://kyg.stanford.edu>: <https://kyg.stanford.edu>

## Teaching

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### STANFORD ADVISEES

#### Postdoctoral Faculty Sponsor

Younghun Kim

#### Doctoral Dissertation Advisor (AC)

Junyi Wang

#### Doctoral (Program)

William Meng, Alex Toews, Benj Wollant

## Publications

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### PUBLICATIONS

- **Acoustic radiation force for analyzing the mechanical stress in ultrasound neuromodulation.** *Physics in medicine and biology*  
Kim, Y. H., Lee, C. H., Firouzi, K., Park, B. H., Pyun, J. Y., Kim, J. N., Park, K. K., Khuri-Yakub, B. T.  
2023; 68 (13)
- **Combining Acoustic Bioprinting with AI-Assisted Raman Spectroscopy for High-Throughput Identification of Bacteria in Blood.** *Nano letters*  
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2023
- **A tool for monitoring cell type-specific focused ultrasound neuromodulation and control of chronic epilepsy.** *Proceedings of the National Academy of Sciences of the United States of America*  
Murphy, K. R., Farrell, J. S., Gomez, J. L., Stedman, Q. G., Li, N., Leung, S. A., Good, C. H., Qiu, Z., Firouzi, K., Butts Pauly, K., Khuri-Yakub, B. P., Michaelides, M., Soltesz, et al  
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- **Multilayer Masking Technology for Fabricating Airborne CMUTs With Multi-Depth Fluidic Trenches** *JOURNAL OF MICROELECTROMECHANICAL SYSTEMS*  
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- **Applications of Capacitive Micromachined Ultrasonic Transducers: A Comprehensive Review** *IEEE TRANSACTIONS ON ULTRASONICS FERROELECTRICS AND FREQUENCY CONTROL*  
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2022; 69 (2): 456-467
- **Comparison of Waveform Modulation Methods Used in Pattern Interference Radiation Force Neuromodulator**  
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IEEE.2022
- **Giant Pressure Output Efficiency of Capacitive Micromachined Ultrasonic Transducers Using Nano-Silicon-Springs**  
Kim, H., Kang, D., Shim, S., Seo, J., Khuri-Yakub, B. T., Lee, B., IEEE  
IEEE.2022
- **Spike frequency-dependent inhibition and excitation of neural activity by high-frequency ultrasound.** *The Journal of general physiology*  
Prieto, M. L., Firouzi, K., Khuri-Yakub, B. T., Madison, D. V., Maduke, M.

2020; 152 (11)

- **Toward rapid infectious disease diagnosis with advances in surface-enhanced Raman spectroscopy.** *The Journal of chemical physics*  
Tadesse, L. F., Safir, F., Ho, C., Hasbach, X., Khuri-Yakub, B. P., Jeffrey, S. S., Saleh, A. A., Dionne, J.  
2020; 152 (24): 240902
- **Wafer-scale Fabrication of Nanometer Silicon Posts for Capacitive Micromachined Ultrasonic Transducers with Substrate-Embedded Springs**  
Kim, H., Kang, D., Kim, J., Khuri-Yakub, B. T., Lee, B., IEEE  
IEEE.2020
- **Wide Bandwidth and Low Driving Voltage Vented CMUTs for Airborne Applications.** *IEEE transactions on ultrasonics, ferroelectrics, and frequency control*  
Ma, B., Firouzi, K., Brenner, K., Khuri-Yakub, B. T.  
2019; 66 (11): 1777–85
- **A Microwave-Induced Thermoacoustic Imaging System With Non-Contact Ultrasound Detection** *IEEE TRANSACTIONS ON ULTRASONICS FERROELECTRICS AND FREQUENCY CONTROL*  
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2019; 66 (10): 1587–99
- **Advances in Capacitive Micromachined Ultrasonic Transducers.** *Micromachines*  
Brenner, K., Ergun, A. S., Firouzi, K., Rasmussen, M. F., Stedman, Q., Khuri-Yakub, B. P.  
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- **Performance Parameters and Frequency Response of CMUTs in Transmit, Receive, and Pulse-Echo Operation**  
Wygant, I., Khuri-Yakub, B. T., Kupnik, M., IEEE  
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- **Multiphase GaN Class-D Resonant Amplifier for High-Intensity Focused Ultrasound**  
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IEEE.2019: 1992–95
- **High Sensitivity and Wide Bandwidth Airborne CMUTs with Low Driving Voltage**  
Ma, B., Firouzi, K., Brenner, K., Khuri-Yakub, B. T., IEEE  
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- **Improved Interface Circuits for CMUT Chemical Sensors**  
Stedman, Q., Fox, J. D., Khuri-Yakub, B. T., IEEE  
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- **Compact Fast-Switching DC and Resonant RF Drivers for a Dual-Mode Imaging and HIFU 2D CMUT Array**  
Stedman, Q., Gu, L., Pai, C., Rasmussen, M., Brenner, K., Ma, B., Ergun, A., Davila, J., Khuri-Yakub, B., IEEE  
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- **An Analytical Model for Capacitive Pressure Transducers With Circular Geometry** *JOURNAL OF MICROELECTROMECHANICAL SYSTEMS*  
Wygant, I. O., Kupnik, M., Khuri-Yakub, B. T.  
2018; 27 (3): 448–56
- **A Column-Row-Parallel Ultrasound Imaging Architecture for 3-D Plane-Wave Imaging and Tx Second-Order Harmonic Distortion Reduction** *IEEE TRANSACTIONS ON ULTRASONICS FERROELECTRICS AND FREQUENCY CONTROL*  
Chen, K., Lee, B., Thomenius, K. E., Khuri-Yakub, B. T., Lee, H., Sodini, C. G.  
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Prieto, M. L., Madison, D. V., Khuri-Yakub, B. T., Maduke, M.  
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- **Activation of Piezo1 but Not NaV1.2 Channels by Ultrasound at 43 MHz.** *Ultrasound in medicine & biology*  
Prieto, M. L., Firouzi, K. n., Khuri-Yakub, B. T., Maduke, M. n.  
2018
- **Localization of weak objects in reverberant fields using waveform inversion** *JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA*  
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2017; 142 (2): 1088–97
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- **Multitouch Touchscreen using Reverberant Lamb Waves**  
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- **Integration of a Dual-Mode Catheter for Ultrasound Image Guidance and HIFU Ablation using a 2-D CMUT Array**  
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- **Efficient Transcranial Ultrasound Delivery via Excitation of Lamb Waves: Concept and Preliminary Results**  
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- **Capsule Ultrasound Device: Characterization and Testing Results**  
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- **Design of Tunable Ultrasonic Receivers for Efficient Powering of Implantable Medical Devices With Reconfigurable Power Loads** *IEEE TRANSACTIONS ON ULTRASONICS FERROELECTRICS AND FREQUENCY CONTROL*

- Chang, T. C., Weber, M. J., Wang, M. L., Charthad, J., Khuri-Yakub, B. (., Arbabian, A.  
2016; 63 (10): 1554-1562
- **<i>Ex-vivo</i> HIFU experiments using a 32×32-element CMUT array.** *IEEE transactions on ultrasonics, ferroelectrics, and frequency control*  
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  - **Noncontact thermoacoustic detection of targets embedded in dispersive media**  
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  - **Capsule Ultrasound Device: Further Developments**  
Memon, F., Touma, G., Wang, J., Baltsavias, S., Moini, A., Chang, C., Rasmussen, M., Nikoozadeh, A., Choe, J., Olcott, E., Jeffrey, R., Arbabian, A., Khuri-Yakub, et al  
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  - **CMUT Chip with Integrated Temperature and Pressure Sensors**  
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  - **CMUT DESIGN EQUATIONS FOR OPTIMIZING NOISE FIGURE AND SOURCE PRESSURE**  
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  - **Standoff Tracking of Medical Interventional Devices using Non-Contact Microwave Thermoacoustic Detection**  
Alexopoulos, G., Boyle, K. C., Dolatsha, N., Nan, H., Khuri-Yakub, B. T., Arbabian, A., IEEE  
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  - **Ultrasound-guided delivery of microRNA loaded nanoparticles into cancer** *JOURNAL OF CONTROLLED RELEASE*  
Wang, T., Choe, J. W., Pu, K., Devulapally, R., Bachawal, S., Machtaler, S., Chowdhury, S. M., Luong, R., Tian, L., Khuri-Yakub, B., Rao, J., Paulmurugan, R., Willmann, et al  
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  - **Non-contact thermoacoustic detection of embedded targets using airborne-capacitive micromachined ultrasonic transducers** *APPLIED PHYSICS LETTERS*  
Nan, H., Boyle, K. C., Apte, N., Aliroteh, M. S., Bhuyan, A., Nikoozadeh, A., Khuri-Yakub, B. T., Arbabian, A.  
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  - **Experimental Study of Mutual Acoustic Coupling in CMUTs with Substrate-Embedded Springs**  
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  - **Dual-Mode Integrated Circuit for Imaging and HIFU With 2-D CMUT Arrays**  
Jang, J., Rasmussen, M., Bhuyan, A., Yoon, H., Moini, A., Chang, C., Watkins, R. D., Choe, J., Nikoozadeh, A., Stephens, D., Oralkan, O., Pauly, K., Khuri-Yakub, et al  
IEEE.2015
  - **Non-Contact Thermoacoustic Imaging of Tissue with Airborne Ultrasound Detection**  
Boyle, K. C., Nan, H., Apte, N., Unlugedik, A., Aliroteh, M. S., Bhuyan, A., Nikoozadeh, A., Khuri-Yakub, B. T., Arbabian, A., IEEE  
IEEE.2015
  - **FABRICATION, PACKAGING, AND CATHETER ASSEMBLY OF 2D CMUT ARRAYS FOR ENDOSCOPIC ULTRASOUND AND CARDIAC IMAGING**  
Moini, A., Nikoozadeh, A., Choe, J., Khuri-Yakub, B. T., Chang, C., Stephens, D., Smith, L., Sahn, D., ASME  
AMER SOC MECHANICAL ENGINEERS.2015
  - **CMUTS IN PERMANENT CONTACT OPERATION FOR HIGH OUTPUT PRESSURE**

Ho, M., Hoffmann, M., Unger, A., Park, K., Kupnik, M., Khuri-Yakub, B. T., ASME AMER SOC MECHANICAL ENGINEERS.2015

- **CMUTS WITH VENTED CAVITIES FOR AIRBORNE APPLICATIONS**  
Apte, N., Nikoozadeh, A., Khuri-Yakub, B. T., Park, K., Crocker, M. J., Pawelczyk, M., Pedrielli, F., Carletti, E., Luzzi, S.  
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- **A Multichannel Oscillator for a Resonant Chemical Sensor System** *IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS*  
Lee, H. J., Park, K. K., Oralkan, O., Kupnik, M., Khuri-Yakub, B. T.  
2014; 61 (10): 5632-5640
- **Singulation for imaging ring arrays of capacitive micromachined ultrasonic transducers.** *Journal of micromechanics and microengineering : structures, devices, and systems*  
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2014; 24 (10)
- **Singulation for imaging ring arrays of capacitive micromachined ultrasonic transducers** *13th International Conference on Micro and Nano Technology for Power Generation and Energy Conversion Applications (PowerMEMS)*  
Chang, C., Moini, A., Nikoozadeh, A., Sarioglu, A. F., Apte, N., Zhuang, X., Khuri-Yakub, B. T.  
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- **Acoustic lens for capacitive micromachined ultrasonic transducers** *24th MicroMechanics and Microsystems Europe Conference (MME)*  
Chang, C., Firouzi, K., Park, K. K., Sarioglu, A. F., Nikoozadeh, A., Yoon, H., Vaithilingam, S., Carver, T., Khuri-Yakub, B. T.  
IOP PUBLISHING LTD.2014
- **Non- Flexural Parallel Piston Movement across CMUT with Substrate-Embedded Springs**  
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IEEE.2014: 591–94
- **Bandwidth and Sensitivity Optimization in CMUTs for Airborne Applications** *IEEE International Ultrasonics Symposium (IUS)*  
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- **Numerical Modeling of Ultrasonic Touchscreen**  
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- **Modeling Elastic Waves in Heterogeneous Anisotropic Media using a k-Space Method**  
Firouzi, K., Nikoozadeh, A., Khuri-Yakub, B. T., IEEE  
IEEE.2014: 1356–59
- **Distinguishing Chemicals Using CMUT Chemical Sensor Array and Artificial Neural Networks**  
Stedman, Q., Park, K., Khuri-Yakub, B. T., IEEE  
IEEE.2014: 162–65
- **A Column-Row-Parallel Ultrasound Imaging Architecture for 3D Plane-wave Imaging and Tx 2nd-Order Harmonic Distortion (HD2) Reduction**  
Chen, K., Lee, B., Thomenius, K., Khuri-Yakub, B. T., Lee, H., Sodini, C. G., IEEE  
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- **Integrated Circuits for Volumetric Ultrasound Imaging With 2-D CMUT Arrays** *IEEE International Solid-State Circuits Flagship Conference of the IEEE Solid-State-Circuits-Society (ISSCC)*  
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- **Dynamic Response of Model Lipid Membranes to Ultrasonic Radiation Force** *PLOS ONE*  
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- **New technologies in clinical ultrasound.** *Seminars in roentgenology*  
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- **New Technologies in Clinical Ultrasound** *SEMINARS IN ROENTGENOLOGY*  
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2013; 48 (3): 214-223
- **Packaging and Modular Assembly of Large-Area and Fine-Pitch 2-D Ultrasonic Transducer Arrays** *IEEE TRANSACTIONS ON ULTRASONICS FERROELECTRICS AND FREQUENCY CONTROL*  
Lin, D., Wodnicki, R., Zhuang, X., Woychik, C., Thomenius, K. E., Fisher, R. A., Mills, D. M., Byun, A. J., Burdick, W., Khuri-Yakub, P., Bonitz, B., Davies, T., Thomas, et al  
2013; 60 (7): 1356-1375
- **GPU-Based Real-Time Volumetric Ultrasound Image Reconstruction for a Ring Array** *IEEE TRANSACTIONS ON MEDICAL IMAGING*  
Choe, J. W., Nikoozadeh, A., Oralkan, O., Khuri-Yakub, B. T.  
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- **Photoacoustic imaging of the bladder: a pilot study.** *Journal of ultrasound in medicine*  
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- **A Comparison Between Conventional and Collapse-Mode Capacitive Micromachined Ultrasonic Transducers in 10-MHz 1-D Arrays** *IEEE TRANSACTIONS ON ULTRASONICS FERROELECTRICS AND FREQUENCY CONTROL*  
Park, K. K., Oralkan, O., Khuri-Yakub, B. T.  
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- **A comparison between conventional and collapse-mode capacitive micromachined ultrasonic transducers in 10-MHz 1-D arrays.** *IEEE transactions on ultrasonics, ferroelectrics, and frequency control*  
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- **3D Volumetric Ultrasound Imaging with a 32x32 CMUT Array Integrated with Front-End ICs Using Flip-Chip Bonding Technology**  
Bhuyan, A., Choe, J., Lee, B., Wygant, I., Nikoozadeh, A., Oralkan, O., Khuri-Yakub, B. T., IEEE  
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- **Dynamic response of model lipid membranes to ultrasonic radiation force.** *PloS one*  
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- **Fabrication of CMUTs with Substrate-embedded Springs** *IEEE International Ultrasonics Symposium (IUS)*  
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- **GPU-Based Real-Time Imaging Software Suite for Medical Ultrasound** *IEEE International Ultrasonics Symposium (IUS)*  
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- **A 32x32 Integrated CMUT Array for Volumetric Ultrasound Imaging** *IEEE International Ultrasonics Symposium (IUS)*  
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- **VOLUMETRIC CHARACTERIZATION OF ULTRASONIC TRANSDUCERS FOR GAS FLOW METERING** *IEEE International Ultrasonics Symposium (IUS)*  
Hoffmann, M., Unger, A., Ho, M., Park, K. K., Khuri-Yakub, B. T., Kupnik, M.  
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- **Experimental evaluation of CMUTs with vented cavities under varying pressure** *IEEE International Ultrasonics Symposium (IUS)*  
Apte, N., Park, K. K., Khuri-Yakub, B. T.  
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- **FINITE ELEMENT ANALYSIS OF MECHANICALLY AMPLIFIED CMUTS** *IEEE International Ultrasonics Symposium (IUS)*  
Unger, A., Hoffmann, M., Ho, M., Park, K. K., Khuri-Yakub, B. T., Kupnik, M.  
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- **Air-coupled CMUTs operating at ambient pressures ranging from 1 to 20 atm** *IEEE International Ultrasonics Symposium (IUS)*  
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- **A Comparison Between Conventional and Collapse-Mode Capacitive Micromachined Ultrasonic Transducers in 10-MHz 1-D Arrays** *Ultrasonics, Ferroelectrics and Frequency Control, IEEE Transactions on*  
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Menz, M., D., Oralkan, O., Khuri-Yakub, P., T., Baccus, S., A.  
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- **Functionalization layers for CO<sub>2</sub> sensing using capacitive micromachined ultrasonic transducers** *SENSORS AND ACTUATORS B-CHEMICAL*  
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