CHEMICALLY ACTIVE CERAMIC OXIDES AND THEIR NANO-HETERO-STRUCTURES

Dr. Sheikh A. Akbar
Visiting Professor
Department of Nanomaterials and Ceramic Engineering, BUET, Dhaka-1000.

Scope and Objectives:

This is a special course covering state-of-the-art in chemically active ceramics and ceramic nano-structures with focus on chemical sensing, catalysis and bioengineering. The topics are covered highlighting the inherent multidisciplinary nature and approach to the same problem. Case studies are presented illustrating sensor fabrication (starting from raw materials to probe fabrication including electrical contact and lead wire attachment) to characterization and field-tests in real-life environments. Recent developments in nano-structured ceramics via gas-phase reactions and thermal annealing of inexpensive and highly scalable non-lithographic manufacturing processes are presented. Potential applications of these nano-structures as platforms for chemical sensing, and bioengineering are also highlighted.

Targeted Audience:

- Senior undergraduate and post-graduate students, researchers and faculty members in engineering, physics, chemistry and bio-engineering.
- Working engineers and scientists in industry.

Timetable:

Date:

30/05/2023	13/06/2023	27/06/2023
03/06/2023	17/06/2023	01/07/2023
05/06/2023	20/06/2023	04/07/2023
10/06/2023	24/06/2023	

Time: 11:00 AM – 1:00 PM

Venue: Seminar Room, Department of Nanomaterials and Ceramic Engineering, OAB.

Topics:

1. Chemical Sensors and the Environment
   Definitions, Markets and trends,
   Applications and challenges
2. Resistive Sensor Materials: Fundamentals
   Gas-solid reaction, Surface states and conduction, Selectivity and interference
3. Specific Resistive/Semiconductive Sensors
   CO sensor – a case study
4. Electrochemical Sensors: Fundamentals
   Galvanic cell thermodynamics
   Electrolytes and electrodes
5. Specific Electrochemical Sensor
   CO_2 sensor – a case study
6. AC Electrical Measurements Applied to Sensors
   Equivalent circuit and complex plane analysis, Modeling of materials behavior, Sensing mechanism.
7. Ceramic Nano-structures (Non-lithographic)
   Fabrication of ceramic nano-structures via gas-phase reaction
   Stress-driven nano-structures in ceramics
   1-D nano-structures by oxidation
   Sensing and biomedical applications
   Opportunities and challenges

About the Instructor

Dr. Sheikh A. Akbar is a Professor of Materials Science and Engineering and Founder of the National Science Foundation (NSF) Center for Industrial Sensors and Measurements (CISM) at The Ohio State University (OSU) in Columbus, OH, USA. After studying for two years (1973-75) in the Physics Department of Dhaka University (Bangladesh), he completed his MS degree in solid state physics from University of Sofia (Bulgaria) in 1980 and PhD in Materials Engineering from Purdue University (USA) in 1985, followed by two years of post-doc and finally joining the faculty of OSU in 1987. His recent work deals with synthesis-microstructure-property relations of ceramic bulk, thin-film and nano-heterostructures. Dr. Akbar was the Chair of the 12th International Conference on Chemical Sensors (IMCS-12) held in 2008. This meeting was attended by 330 participants from more than 30 countries. He was also a major symposium organizer of IMCS-18 in 2021. Dr. Akbar's sensors received three (3) R&D 100 Awards as part of the 100 best inventions of 2007 and 2005 selected by R&D Magazine and 2005 NASA TGIR (turning goal into reality) award. Dr. Akbar is the recipient of the 2012 Electrochemical Society Sensor Division Outstanding Achievement Award, the 2002 Tan Chin Tuan Fellow of Nanyang Technological University in Singapore, and the 2001 Fulrath Award and the 2002 W.E. Cramer Award of the American Ceramic Society. He was elected a Fellow of the American Ceramic Society (ACerS) in 2001 and a Fellow of the Electrochemical Society (ECS) in 2018. He also received the 1993 B.F. Goodrich Collegiate Inventors Award for the development of a rugged and durable CO/H_2 sensor; *one of three national awards.* Dr. Akbar has served on the International Advisory Committee of CIMTEC conferences, Steering Committee of the International Conference on Engineering Education (ICEE), Technical Steering Committee of the US-DOE Sensor and Controls Program, and the Steering Committee of the US-Japan Conference on Sensor Systems for the 21st Century. He has co-organized sensor symposia for the American Ceramic Society, the Electrochemical Society, IMCS (USA, Korea, Austria, Canada), ICMAT (Singapore), AMEC-4 (China), ICC3 (Japan), CMCEE (Canada) and ICC8 (Korea). Dr. Akbar has co-edited 2 books on sensors. In 2003, he served as the Guest Editor for two special sections of the Journal of Materials Science, "Chemical Sensors for Pollution Monitoring and Control" and "Chemical and Bioceramics." He was the Principal Editor of special issues entitled, "Nano-structured Ceramic Oxides: Challenges and Opportunities" and "Energy and Environment: Role of Advanced Materials" published by the American Scientific Publisher in 2011 and 2014, respectively. He was also the Guest Editor of a special issue entitled, "Sensing at the Nano-scale: Chemical and Biosensing" published in 2012 in *Sensors* and "Nano-hetero-structures for Chemical Sensing: Opportunities and Challenges" published in Frontiers in Materials in 2019. He was a distinguished lecturer in 2017 SJTU International Summer School of Advanced Materials (ISS-AM) in Shanghai, China. Dr. Akbar was elected an Editor of Sensors and Actuators B Chemical in 2018, a role he is continuing. He has served on the Editorial Boards of the Journal of Nanoengineering and Nanomanufacturing, Materials Focus, Sensors, Ceramics International, Journal of Nanomaterials, Sensor Letters and Frontiers in Materials (Functional Ceramics Chief Editor). He has published more than 265 technical papers and holds 8 patents garnering over 12750 citations with an h-index of 52. Dr. Akbar received the Mars G. Fontana Outstanding Teacher Award in Materials Science and Engineering (OSU) for both 2016 and 2017. In 2023, he received the Alumni Distinguished Teaching Award, the highest distinction in teaching at OSU.