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BENJAMIN M. STATLER COLLEGE OF ENGINEERING AND MINERAL RESOURCES

MATERIALS SCIENCE AND ENGINEERING (MS&E) SEMINAR SERIES
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Ceramic Nano-heterostructures by Materials Design: Platforms for Sensing, Catalysis and Biomedical Applications

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This talk summarizes R&D efforts in the author's laboratory on the fabrication of oxide nano-heterostructures, exploiting intrinsic material properties, that are highly scalable and do not require use of lithography. One such process creates crystallographically oriented nanofiber arrays of single crystal TiO_2 in H_2/N_2 environment. H_2/N_2 heat treatment was also used to grow nanofibers on polycrystalline SnO_2, showing directional growth on grains with crystal facets. We have also developed a process to create nanofibers of TiO_2 on Ti metal/alloys via oxidation under a limited supply of oxygen. We have succeeded in converting the 1-D TiO_2 nano-fiber grown by thermal oxidation to nano-dendritic titanates by hydrothermal treatment. In another process, SnO_2 nanowires grown from commercial FTO slides using the vapor-liquid-solid (VLS) method were placed in a microwave-assisted hydrothermal chamber where TiO_2 nanorods nucleated radially from the SnO_2 nanowire cores. We developed yet another interesting nano-structure (nanoislands and/or nanobars) during thermal annealing of an oxide (GDC) on top of another oxide (YSZ) substrate that self-assembles along the softest elastic direction of the substrate. What is common about these structures is that they are fabricated without the use of lithographic techniques and involves simple processes such as gas-phase reactions and stress-driven processes. These nano-structures can be used as platforms for chemical sensing, catalysis, photocatalysis, photovoltaics and biomedical applications. Preliminary results of some of these applications are presented including an Open access Database Of Resistive type gas Sensors (ODORS) that is under development.

Short Bio-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 in Columbus, OH, USA. 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. His 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 in 2001 and a Fellow of the Electrochemical Society 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) and CMCEE (Canada). 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" being 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 in 2018. He is also 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 (Function Ceramics Chief Editor). He has published more than 225 technical papers and holds 8. Dr. Akbar received the Mars G. Fontana Outstanding Teacher Award in Materials Science and Engineering for both 2016 and 2017.

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