CURRICULUM VITAE

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PROFESSIONAL APPOINTMENTS

Sept. 2017- **Research Professor,** Dept. of Material Sci. and Engineering, Northwestern University

Sept. 2013-2017: **Research Associate Professor,** Dept. of Material Science and Engineering, Northwestern University**.**

Sept. 2002-2013: **Research Assistant Professor,** Dept. of Material Science and Engineering, Northwestern University**.**

Sept.2002-Present: **Manager, Scanned Probe Imaging and Development Facility**

Aug. 1999-2002 **Scientist**, School of Nanosciences and Nanoengineering, University at Albany, Albany, NY

EDUCATION

1996 **Ph.D. (Material Science), Rajasthan University and** Central Electronics Engineering Research Institute (CEERI), INDIA

1991 **M.S**. (Applied Physics), ML Sukhadia University, INDIA

Task Leader

August 2017-Present: **Advisor**, Applied Nanostructure Inc.

2015-Present: **Technical Task Leader**, SHyNE Resource, A NNCI Undertaking

2022-Present **Key Personnel** for SHyNE resource in **Rule of Life (ROL) and Global Research Initiative (GRI).**

July 2013-2018 **Team Member**, International Exchange Program between University of Basel (Christopher Gerber) and ETZ Switzerland (Daniel Mueller) on Cantilever based medical diagnostics systems and Biomechanics.

April 2003-Present **Task Leader,** International exchange program between Institute for Microbial Technology, Chandigarh, and NU on integrated receptor development for biological sensors.

July 2005-2008 **Task leader, Semiconductor Research Council,** Developing Nanomechanical sub-surface Nano-metrology for imaging buried defects for in-line semiconductor processing.

Sept. 2002-Present **Manager, Scanned Probe Imaging and Development (SPID-NU*ANCE*) Facility.** The center provides classroom teaching, short courses, hands-on-experience and advanced level teaching on Advanced Scanning probe microscopy, Raman spectroscopy and nanopatterning to academic and industrial users. Center also develops new capabilities and systems. Founding member of SPID (formerly NIFTI) center and responsible building the whole SPID center with Advanced Scanning probe Microscopies and Nanopatterning for NU, other academic and Industrial users.

Sept. 2015-Present **Key Personnel and Technical Task Leader-SHyNE Resource:** The Soft and Hybrid Nanotechnology Experimental (SHyNE) Resource is a joint venture between Northwestern University (1) and the Pritzker Nanofabrication Facility (PNF) (2) of University of Chicago. I am the key personnel and technical task leader for Rule of Life (ROL) and GRI (Global research Initiative). In addition, I worked with SHyNE director directly in planning, proposal writing, annual reports, work force developments, teaching and many other SHyNE related activities.

Apart from active research participation, I am also involved in day-to-day operation of Scanning probe microscopy and nanopatterning center. Over the last 22 years, SPID has been completely transformed into a world class SPM imaging and nanopatterning facility with very high-end instrumentations that have capabilities of performing both qualitative and quantitative measurements. Successfully acquired office of research support as well as from other institutions and built the entire suites of high-performance instrumentation.

RESEARCH STATEMENT

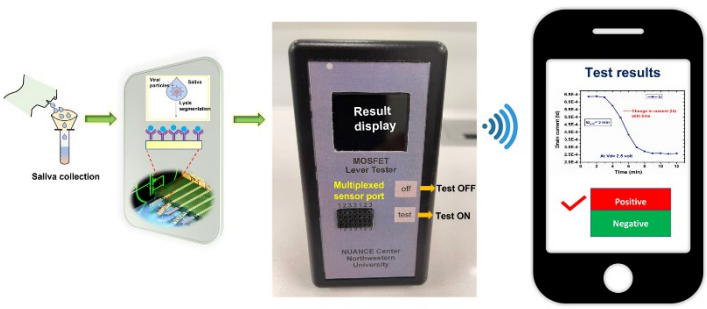
At Northwestern, I developed multiple programs that merge nanoelectronics with biomedicine, biomechanics for therapies, nanopatterning, smart sensors and instrumentation development. During the last 4-5 years, I developed electro-mechanical chip-based sensors for SARS-2-CoV, H1N1, RSV and other pathogens detection via saliva, blood serum and breath. Programs have been developed with the same technology for detection of HIV and water-based contaminations. Established long term research collaborative partnerships with medical school, synthetic biology, Bruker corporation, Applied Nanostructures, pulmonary division at UIC along with overseas programs. Along with research programs, I am directing Scanned probe imaging and development facility which provides functional SPM, chemical imaging with Raman-TERS, biomechanics and nanopatterning based imaging capabilities to wide range diverse user community and industries. Some of the current research activities during the **last 6 years** are highlighted in brief.

1. **Point-of-Care NEMS-based Diagnostics Platform for Multiplexed Detection of HIV p-24 antigen, HCV Core Antigen and HBV Surface Antigen in Human Blood (Collaboration with Judd Hultquist, -FSM Medical School)**

NIH-CFAR (Center for AIDS research) supplement funding has just been approved to develop NEMS-based diagnostic platform for the quantitative, multiplex detection of HIV p24 antigen, HCV core antigen (cAg), and HBV surface antigen (sAg) in human blood. The final platform will be tested using de-identified, human blood specimens from people living with HIV, HBV, and/or HCV to assess specificity and sensitivity. Ultimately, these studies will assess the potential for developing next-generation, point-of-care platforms for the multiplexed detection of HIV, HBV, and HCV towards facilitating real-time clinical care decision making and the mitigation of syndemic disease burden.

2. **Rapid Multiplexed Detection of SARS-CoV-2 using NEMS-based Diagnostics sensors and Synthetic biology based Mini-Binders (Collaborators: Michael Jewett-NU, David Baker-Univ. of Washington, Vara Prasad-Cleveland Clinic, John Sullivan-NIH)**

We developed integrated sensors for rapid detection of SARS-CoV-2 spike (S) glycoprotein antigen using computationally designed multivalent minibinders immobilized on a microcantilever surface. The sensor exhibits rapid (< 5 min) detection of the target antigens down to concentrations of 0.05 ng/mL (362 fM) and is more than an order of magnitude more sensitive than an antibody-based cantilever sensor. We have validated the sensor with clinical samples from 33 patients, including 9 patients infected with the Omicron (BA.1) variant observed detection of antigen from nasopharyngeal swabs with cycle threshold (Ct) values as high as 39, suggesting a limit of detection similar to that of



the quantitative reverse transcription polymerase chain reaction (RT-qPCR). We have developed an array of ten silicon based MOSFET-embedded direct readout cantilevers that were used to detect different respiratory disease pathogen biomarkers through exhaled breath from different patients. Subjects suffering from COVID-19 symptoms (Delta variant), Influenza A, H1N1 (Swine flu), Enterovirus mediated disease, and Pneumonia volunteered for this study along with some healthy patients (control). The arrays were prior bio-functionalized using different capillaries (channels) filled with individual antibody solution against these viral antigens.

http://www.nuance.northwestern.edu/news-and-events/articles/2021/2021-10-04_GS_COVID-test.html

https://www.mccormick.northwestern.edu/news/articles/2021/09/new-covid-19-antigen-testing-method-offers-highly-accurate-results-in-under-3-minutes/

3. **Sub-surface Analysis of Voids, Cracks, delamination's using Scanning Ultrasound Holography (Collaboration with Michal Jones and Masato Hozumi-Toyota Motor Corporation-North America).**

We are collaborating with Toyota motor corporation to implement our in-house developed scanning near field ultrasound holography to image sub-surface defects, voids, and delamination for failure analysis of materials used in their automobiles. The collaboration have recently started with NDA signed with them to analyze samples. This will soon be developed into a funded program by Toyota Motor Incorporation.

4. **Ovarian and Brian Tissues Biomechanics (Collaboration with Francesca Duncan, Brian Popko and Benayahu Eilon-Feinberg Medical School, Steven Dudek, Pulmonary division head at UIC)**

We have been collaborating with folks at Medical school over the last few years and developing protocols for quantitative biomechanics for ovarian and mouse brain tissues. Using instrumental indentation, we demonstrated a quantitative increase in ovarian stiffness, as evidenced by an increase in Young's modulus, when comparing ovaries from reproductively young (6–12 weeks) and old (14–17 months) mice. In addition to collagen, we also investigated the role of hyaluronan (HA) in regulating ovarian stiffness. Similar studies have been done with Mouse brain tissues. Recently Prof. Eilon has submitted an R01 Grant and I am listed as the key personnel in that grant.

I have been collaborating for long time with Steve Dudek at UIC for Quantitative nanomechanics of endothelial cells to develop therapeutics for acute lung injuries and study the complex dynamics of biological structures at nanoscale resolution, under physiologically viable and non-invasive conditions. This joint research resulted in several joint publications and NIH funding.

5. **Developed Methods to Identify the Nanomechanics of Hybrid organic-inorganic perovskites (HOIPs)**

Systematically developed the fracture mechanical properties of 3D/2D HOIP single crystals and thin films with different chemical composition and structures to understand the study will significantly expand the understanding of the structure-fracture-mechanical property relationship of HOIPs. This fracture mechanical information provided indispensable insight into design mechanically durable PV module and flexible electronics based on HOIPs.

PUBLICATIONS

1. Kunmo Koo, Zhiwei Li, Yukun Liu, Stephanie Ribet, Xianbiao Fu, P. Smeets, Xinqi Chen, Gajendra Shekhawat, Jungjae Park, J. Min Yuk and V. Daivd. Ultrathin silicon nitride microchip for in-situ/operando microscopy with high resolution and spectral visibility. Nanoture Nanotechnology (NNANO-23061473-Under Review).
2. Dilip K. Agarwal, Tyler J. Lucci Jaeyoung K. Jung, Gajendra S. Shekhawat, Julius B. Lucks and Vinayak P. Dravid. Synthetic biology integrated nanomechanical platform for the ultra-sensitive detection of harmful water contaminants. Manuscript under submission.
3. Belvitch, P., Casanova, N., Sun, X., Camp, S. M., Sammani, S., Brown, M. E., Mascarhenas, J., Lynn, H., Adyshev, D., Siegler, J., Desai, A., Seyed-Saadat, L., Rizzo, A., Bime, C., Shekhawat, G. S., Dravid, V. P., Reilly, J. P., Jones, T. K., Feng, R., Letsiou, E., & 4 others, Jun 2022, In: Translational Research. 244, p. 56-74 19 p. A cortactin CTTN coding SNP contributes to lung vascular permeability and inflammatory disease severity in African descent subjects**.**
4. Agarwal, D. K., Nandwana, V., Henrich, S. E., Josyula, V. P. V. N., Thaxton, C. S., Qi, C., Simons, L. M., Hultquist, J. F., Ozer, E. A., Shekhawat, G. S. & Dravid, V. P., Jan 1 2022, In: Biosensors and Bioelectronics. 195, 113647. Highly sensitive and ultra-rapid antigen-based detection of SARS-CoV-2 using nanomechanical sensor platform
5. Agarwal, D. K., Hunt, A. C., Shekhawat, G. S., Carter, L., Chan, S., Wu, K., Cao, L., Baker, D., Lorenzo-Redondo, R., Ozer, E. A., Simons, L. M., Hultquist, J. F., Jewett, M. C. & Dravid, V. P., Jun 14 2022, In: Analytical Chemistry. 94, 23, p. 8105-8109 5 p. Rapid and Sensitive Detection of Antigen from SARS-CoV-2 Variants of Concern by a Multivalent Minibinder-Functionalized Nanomechanical Sensor
6. Eugenia S Vasileiadou, Xinyi Jiang, Mikaël Kepenekian, Jacky Even, Michael C De Siena, Vladislav V Klepov, Daniel Friedrich, Ioannis Spanopoulos, Qing Tu, G. Shekhawat, Imra S Tajuddin, Emily A Weiss, Mercouri G Kanatzidis,* "Thick-Layer Lead Iodide Perovskites with Bifunctional Organic Spacers Allylammonium and Iodopropylammonium Exhibiting Trap-State Emission", *Journal of the American Chemical Society, 2022, 144 (14), 6390-6409*
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9. Gao, X., Jiang, Y., Lin, Y., Kim, K. H., Fang, Y., Yi, J., Meng, L., Lee, H. C., Lu, Z., Leddy, O., Zhang, R., Tu, Q., Feng, W., Nair, V., Griffin, P. J., Shi, F., Shekhawat, G. S., Dinner, A. R., Park, H. G. & Tian, B. Structured silicon for revealing transient and integrated signal transductions in microbial systems. Jan 1 2020, Science Advances. 6, 7, eaay2760.
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