BIOGRAPHICAL SKETCH

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NAME: Du, Ke

eRA COMMONS USER NAME (credential, e.g., agency login): KE.DU1

POSITION TITLE: Assistant Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE (if applicable)	END DATE MM/YYYY	FIELD OF STUDY
University of Science and Technology, Beijing, Beijing	BS	07/2007	Materials Physics
University of South Florida , Tampa, Florida	MS	01/2009	Mechanical Engineering
Stevens Institute of Technology, Hoboken, New Jersey	PHD	01/2015	Mechanical Engineering
University of California, Berkeley, California	Postdoctoral Fellow	08/2018	Chemistry/Bioengineering

A. Personal Statement

My research lab is interested in nanobiosensing, mechanobiology, optogenetics, and nanomanufacturing. One of our projects is to develop sensitive and specific point-of-care (POC) systems for infectious diseases and cancers. Recently, we developed a prototype of funnel adapted sensing tube (FAST) with BMI for power-free and pipette-free detection of SARS-CoV-2 RNA fragments. An isothermal amplification process is coupled with a CRISPR-Cas12a assay, achieving a detection limit of 10 fM. This detection system is operated by manually transferring and mixing the reagents in a 3-D printed device without the needs for electrical power, designed to be used in low resource limited settings or simple home tests. In addition, we developed a computer vision based linear kernel algorithm for low light detection without using expensive instruments. This algorithm can easily be developed as a smartphone app for remote sensing and reading. In this proposal, we aim to improve our FAST system to be a commercialization product for the multiplexing detection of human papillomavirus infection and parasites. Our lab has been working with BMI for several years and we enjoy the fruitful collaboration (see publication 1 and 3). I have the technical background and project management experience to lead the successful completion of the proposed work. In addition, our lab has access to all experimental equipment and resources that are needed to complete the proposed research. In summary, I have a demonstrated record of innovation and leadership in the field of POC systems, providing ample preparation for directing this project.

1. Bao, Mengdi, Shuhuan Zhang, Chad Ten Pas, Stephen J. Dollery, Ruth V. Bushnell, F. N. U. Yuqing, Rui Liu, Guoyu Lu, Gregory J. Tobin, and **Ke Du***. "Computer vision enabled funnel adapted sensing tube (FAST) for power-free and pipette-free nucleic acid detection." Lab on a Chip (2022).
2. Chang, Yu, Mengdi Bao, Jacob Waitkus, Haogang Cai, and **Ke Du***. "On-Demand Fully Enclosed Superhydrophobic–Optofluidic Devices Enabled by Microstereolithography." Langmuir 38, no. 34 (2022): 10672-10678.
3. Liu, Li, Zhiheng Xu, Kamel Awayda, Stephen J. Dollery, Mengdi Bao, Jianlin Fan, Denis Cormier, Mitchell R. O'Connell, Gregory J. Tobin, and **Ke Du***. "Gold Nanoparticle-Labeled CRISPR-Cas13a Assay for the Sensitive Solid-State Nanopore Molecular Counting." Advanced Materials Technologies 7, no. 3 (2022): 2101550.
4. Hass, Kenneth N., Mengdi Bao, Qian He, Li Liu, Jiacheng He, Myeongkee Park, Peiwu Qin, and **Ke Du***. "Integrated micropillar polydimethylsiloxane accurate CRISPR detection system for viral DNA sensing." ACS omega 5, no. 42 (2020): 27433-27441.

B. Positions, Scientific Appointments and Honors

Positions and Scientific Appointments

2022 -	Assistant Professor, University of California, Riverside, Riverside, CA
2018 - 2022	Assistant Professor, Rochester Institute of Technology, Rochester, NY

Honors

2021	NIH Maximizing Investigators' Research Award (MIRA), NIH
2021	Colgate Innovation Award, Colgate Palmolive
2020	Finalist, Microsystems and Nanoengineering Young Scientists Awards
2020	Rising Star in Sensing, American Chemistry Society
2019	Travel Grant, Burroughs Wellcome Fund
2014	James H. Potter Award, Stevens Institute of Technology

C. Contribution to Science

1. Nanobiosensing: My lab is striving to develop detection systems and assays for the sensitive detection of biomarkers such as nucleic acids and proteins. For example, my lab developed a fully integrated microfluidic system and fluorescence sensing unit for the liquid phase CRISPR-Cas13a detection assay. Within 5 min, a detection limit of 2 pfu/mL of purified Ebola RNA was achieved without amplification. This system has also been used for CRISPR-Cas12a detection of African swine fever virus. Recently, we developed a magnetic bead-quantum dot assay for simple naked-eye virus sensing. The magnetic beads are used to capture the DNA probes and also remove the impurities. Thus, the detection sensitivity is not affected by the presence of bodily fluids. A solid-phase CRISPR assay based on PDMS micropillars was also developed by us for one-step and background free viral DNA sensing. All these work set the foundation for the proposed CRISPR system of immobilizing quantum dot reporters on the ultra-high aspect ratio nanostructures.

a. He, Qian, Dongmei Yu, Mengdi Bao, Grant Korensky, Juhong Chen, Mingyeong Shin, Juwon Kim, Myeongkee Park, Peiwu Qin, and **Ke Du***. "High-throughput and all-solution phase African Swine Fever Virus (ASFV) detection using CRISPR-Cas12a and fluorescence based point-of-care system." Biosensors and Bioelectronics 154 (2020): 112068.

b. Yang, Fan, Li Liu, Pierre Fernand Neuenschwander, Steven Idell, Ramakrishna Vankayalapati, Krishan Gopal Jain, Ke Du, Honglong Ji, and Guohua Yi. "Phage Display-Derived Peptide for the Specific Binding of SARS-CoV-2." ACS omega 7, no. 4 (2021): 3203-3211.

c. Bao, Mengdi, Erik Jensen, Yu Chang, Grant Korensky, and **Ke Du***. "Magnetic bead-quantum dot (MB-Qdot) clustered regularly interspaced short palindromic repeat assay for simple viral DNA detection." ACS applied materials & interfaces 12, no. 39 (2020): 43435-43443.

d. Qin, Peiwu, Myeongkee Park, Kendra J. Alfson, Manasi Tamhankar, Ricardo Carrion, Jean L. Patterson, Anthony Griffiths, Qian He, Ahmet Yildiz, Richard Mathies, and **Ke Du***. "Rapid and fully microfluidic Ebola virus detection with CRISPR-Cas13a." ACS sensors 4, no. 4 (2019): 1048-1054.

2. Mechanobiology: Characterizing the mechanical properties of cells and tissues is important for the understanding of various diseases. Microfluidic devices have been widely used to analyze single cells, such as tumor cells, stem cells, and microorganisms. We developed a microfluidic system for the in situ studies of cell mechanics and cell-to-cell interaction. By using microalgae cells as a model, we showed that the cells could be physically immobilized in a transparent channel by nanochannel confinement without using chemicals such as paraformaldehyde solution. The height of the nanochannel is tuned by adjusting the roof deformation; thus, it can provide quantitative information on cell mechanics. We also showed that the in situ co-culture of bacteria and microalgae results in the cell wall damage of the microalgae, demonstrating that this nano-sieve device is a useful platform to study cell to cell communication. Currently, the PI's lab is studying the endocytosis behavior of the microalgae cells by using fluorescent nanoparticles, total internal reflection fluorescence microscope imaging, and molecular dynamic simulations. The new knowledge we gain in this project can then be used to understand the interactions between nanomaterials and cells such as microorganisms, tumor cells, and stem cells.

a. Chen, Xinye, Shuhuan Zhang, Yu Gan, Rui Liu, Ruo-Qian Wang, and **Ke Du***. "Understanding microbeads stacking in deformable Nano-Sieve for Efficient plasma separation and blood cell retrieval." Journal of Colloid and Interface Science 606 (2022): 1609-1616.

b. Korensky, Grant, Xinye Chen, Mengdi Bao, Abbi Miller, Blanca Lapizco-Encinas, Myeongkee Park, and **Ke Du***. "Single Chlamydomonas reinhardtii cell separation from bacterial cells and auto-fluorescence tracking with a nanosieve device." Electrophoresis 42, no. 1-2 (2021): 95-102.

c. Chen, Xinye, Shengting Cao, Yu Gan, Jie Zhang, Qian He, Ruo-Qian Wang, Xin Yong, Peiwu Qin, Blanca Lapizco-Encinas, and **Ke Du***. "Efficient Escherichia coli (E. coli) Trapping and Retrieval from Bodily Fluids via a Three-Dimensional (3D) Microbeads Stacked Nano-Device." (2019).

d. Chen, Xinye, Luke Falzon, Jie Zhang, Xiaohui Zhang, Ruo-Qian Wang, and **Ke Du***. "Experimental and theoretical study on the microparticle trapping and release in a deformable nano-sieve channel." Nanotechnology 31, no. 5 (2019): 05LT01.

3. Optofluidics and Optogenetics: Brain imaging is an emerging field for the study of immunology, neuroscience, and virology. We recently developed a liquid-core and air-cladding waveguide platform for efficient light signal collection and local drug delivery. The very high hydrophobicity at the air-solid-liquid interface creates a large air pocket at the interface. Based on the effective refractive (n_{eff}) model, the n_{eff} value at the interface approaches 1 and significantly reduced the waveguide loss, enabling highly efficient fluorescence collection. This breakthrough, coupling with the quantum dot labeled CRISPR assay we developed, will achieve ultra-sensitive fluorescence detection and only require an LED array to excite the waveguide chip, ideal for miniaturized and multiplexing detection. More importantly, this waveguide chip allows deep layer stimulation in the brain tissues to treat neurological problems such as depression and Alzheimer's disease. Our low loss waveguide channel is directly patterned on PDMS, a biocompatible, inert, soft, and transparent material, ideal for in vivo study. Importantly, the liquid core can also be used to deliver therapeutic agents such as CRISPR reagents, vaccines, and drugs into the tissues/organs with a programmable flow rate and is superior to the state of art solid-core waveguide configurations.

a. Chang, Yu, Mengdi Bao, Jacob Waitkus, Haogang Cai, and **Ke Du***. "On-Demand Fully Enclosed Superhydrophobic–Optofluidic Devices Enabled by Microstereolithography." Langmuir 38, no. 34 (2022): 10672-10678.

b. Ke Du, Ishan Wathuthanthri, Junjun Ding, and Chang-Hwan Choi. "Superhydrophobic waveguide: Liquid-core air-cladding waveguide platform for optofluidics." Applied Physics Letters 113, no. 14 (2018): 143701.

c. Ke Du, Myeongkee Park, Anthony Griffiths, Ricardo Carrion, Jean Patterson, Holger Schmidt, and Richard Mathies. "Microfluidic system for detection of viral RNA in blood using a barcode fluorescence reporter and a photocleavable capture probe." Analytical chemistry 89, no. 22 (2017): 12433-12440.

d. Ke Du., H. Cai, M. Park, T. A. Wall, M. A. Stott, K. J. Alfson, A. Griffiths et al. "Multiplexed efficient on-chip sample preparation and sensitive amplification-free detection of Ebola virus." Biosensors and Bioelectronics 91 (2017): 489-496.

4. Nanomanufacturing: My lab is dedicated to understanding the interactions between biomolecules and nanostructures at the single-molecule level to enhance biomarker trapping and sensing. We developed several novel nanolithography techniques for the unconventional patterning of micro-and nanostructures on microfluidic devices. A novel stencil lithography was developed based on a flexible nanofilm. Nanostructures were defined on the nanofilm by using laser interference lithography and can be used as a template to fabricate nanofeatures on various substrates. Patterning uniform and scalable micro-and nanostructures on unconventional substrates enables many applications such as disposable sensors and implantable devices. By using this technique, we are developing a lab-on-fiber platform for simple molecular diagnosis.

a. Liu, Yuyang, Ke Du, Ishan Wathuthanthri, Wei Xu, and Chang-Hwan Choi. "Freestanding Photoresist Film: A Versatile Template for Three-Dimensional Micro-and Nanofabrication." Advanced Functional Materials 30, no. 42 (2020): 2004129.

b. Ke Du, Junjun Ding, Ishan Wathuthanthri, and Chang-Hwan Choi. "Selective hierarchical patterning of silicon nanostructures via soft nanostencil lithography." Nanotechnology 28, no. 46 (2017): 465303.

c. Jiang, Youhua, Jian Xu, Junghoon Lee, Ke Du, Eui-Hyeok Yang, Myoung-Woon Moon, and Chang-Hwan Choi. "Nanotexturing of conjugated polymers via one-step maskless oxygen plasma etching for enhanced tunable wettability." Langmuir 33, no. 27 (2017): 6885-6894.

d. Ke Du, Yuyang Liu, Ishan Wathuthanthri, and Chang-Hwan Choi. "Fabrication of hierarchical nanostructures using free-standing trilayer membrane." Journal of Vacuum Science & Technology B, Nanotechnology and Microelectronics: Materials, Processing, Measurement, and Phenomena 31, no. 6 (2013): 06FF04.