BIOGRAPHICAL SKETCH

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NAME: Wang, Shan X.

eRA COMMONS USER NAME (credential, e.g., agency login): WANG.SHAN

POSITION TITLE: Full Professor, Director of Stanford Center for Magnetic Nanotechnology, Associate Chair of Dept. of Materials Science and Engineering

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)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Science and Technology of China	B.S.	07/1986	Physics
Iowa State University	M.S.	07/1988	Physics
Carnegie Mellon University	Ph.D.	12/1993	Electrical and Computer Engineering

A. Personal Statement

Over the past 15 years the Shan Wang lab made distinctive contributions to magneto-nanosensors and has been considered among the select few pioneers in the use of magnetic nanoparticles (MNP) and giant magnetoresistive (GMR) sensors for bio-detection of circulating proteins and nucleic acids. The Wang lab published a series of important papers and patents on MNP, GMR biosensor, MNP-mediated kinetic assay, advanced reverse phase array, and their biological applications (e.g., PNAS, 2008; US Patent No. 7,419,639; Nature Medicine, 2009; Nature Nanotechnology, 2011; US Patent Application 13/861,120; Nature Communications, 2013 & 2016; ACS Nano, 2017). The Wang lab reported attomolar to femtomolar sensitivities for protein biomarkers, and versatile assays of DNA, RNA, and small molecules. The technology platform is being applied to in vitro diagnostics of cancer, radiation exposure, autoimmunity, genotyping, and epigenomics. The magneto-nanosensors have spurred several clinical studies in lung cancer, prostate cancer, liver cancer, colorectal cancer, autoimmunity, radiation exposure, hepatitis, marijuana DUI, and mental health. Wang also invented a 3D portable cell or DNA sorter called magnetic sifter (MagSifter) which is well suited for enriching and harvesting circulating tumor cells (CTC, and other rare cells) and circulating tumor DNA (ctDNA) (US Patents No. 7,615,382 & No. 8,481,336; PNAS, 2016) and took the lead to integrate MagSifter with Nanowell-based single CTC mRNA assays. He has served as a mentor or advisor for numerous undergrads, grad students, and postdocs over a 25-year span at Stanford University. His strong track record in innovation, cross-disciplinary collaboration, and mentoring, allows him to contribute actively to the proposed project.

B. Positions and Honors

Positions Held

1993-2000 Assistant Professor, Dept. of Materials Science & Engineering, and jointly with Dept. of Electrical Engineering, Stanford University
2001-2006 Associate Professor, Dept. of Materials Science & Engineering, and jointly with Dept. of Electrical Engineering, Stanford University
2006-present Full Professor, Dept. of Materials Science & Engineering, and jointly with Dept. of Electrical Engineering, Stanford University
2010-present Full Professor by courtesy, Dept. of Radiology, Stanford School of Medicine
2002-2005 Director, Stanford Center for Research on Information Storage Materials (CRISM)
2005-present Director, Stanford Center for Magnetic Nanotechnology
2003-present Affiliated Faculty Member, Stanford Bio-X Program

2012-present Associate Faculty Member, Canary Center for Early Detection of Cancer
2014-present Associate Chair, Department of Materials Science and Engineering

Honors and Awards

1986	CUSPEA Scholarship organized by Nobel Laureate T. D. Lee
1994-1997	Inaugural Frederick Terman Faculty Fellow
1999	IBM Partnership Award
2001-2002	IEEE Magnetics Society Distinguished Lecturer
2006	Co-author of the best student paper of International Electronic Device Meeting (IEDM)
2007-2008	Obducat Prize 2007 Award (1st Prize)
2009	BMEidea Competition 1st Prize; IEEE Change the World Competition 1st Prize
2009	Fellow of the Institute of Electrical and Electronics Engineers (IEEE)
2010	Gates Foundation Grand Challenge Explorations Award
2012	Fellow of American Physical Society (APS)
2013	IBM Faculty Award
2014	XPRIZE Foundation's Nokia Sensing XCHALLENGE Distinguished Award
2015	Faculty Fellow, Center for Innovation and Global Health (CIGH)
2017	XPRIZE Bold Epic Innovator Award (co-winner with Cloud DX)
2017	Professor in Residence, StartX, Stanford University

C. Contribution to Science

1. Wang's most innovative work is pioneering the development of giant magnetoresistive (GMR) biochips, aka magneto-nanosensors, into an ultrasensitive and multiplex protein assay platform suitable for cancer diagnostics. *More recently, he has extended the chip platform to simultaneous profiling of DNA mutation and methylation*. He has some 50 issued or pending patents in this area. Partly because of these, he was elected a Fellow of the American Physical Society (APS) "for seminal contributions to biomagnetics, nanomagnetics, and magnetic recording" in 2012. His work has attracted wide public interests and media coverage, including ABC News and San Jose Mercury News. The resulting technologies have been out-licensed for clinical translation, including diagnostics of lung cancer, prostate cancer, autoimmunity, infectious diseases, and drug abuses. The representative papers and patents on the magneto-nanosensors are as follows:
   a. S. J. Osterfeld, H. Yu H, R. S. Gaster, S. Caramuta, L. Xu, S.-J. Han, D. A. Hall, R. J. Wilson, S. Sun, R. L. White, R. W. Davis, N. Pourmand, and S. X. Wang, "Multiplex Protein Assays Based on Real-Time Magnetic Nanotag Sensing," *PNAS*, **105**, 20637-20640, 2008. (PMCID: PMC2602607)
   b. R. S. Gaster, D. A. Hall, C. H. Nielsen, S. J. Osterfeld, H. Yu, K. E. Mach, R. J. Wilson, B. Murmann, J. C. Liao, S. S. Gambhir, and S. X. Wang, "Matrix-insensitive protein assays push the limits of biosensors in medicine," *Nature Medicine*, **15**, 1327-1332, 2009. (PMCID: PMC4165514)
   c. Giovanni Rizzi, Jung-Rok Lee, Christina Dahl, Per Guldberg, Martin Dufva, Shan X. Wang, and Mikkel F. Hansen, "Simultaneous Profiling of DNA Mutation and Methylation by Melting Analysis Using Magnetoresistive Biosensor Array," *ACS Nano*, 11, 8864-8870, 2017. (PMCID: PMC5810360)
   d. L. Xu, H. Yu, M. S. Akhras, S.-J. Han, S. J. Osterfeld, R. L. White, N. Pourmand, S. X. Wang, "Giant magnetoresistive biochip for DNA detection and HPV genotyping," *Biosensors and Bioelectronics*, **24**, 99–103, 2008. (PMCID: PMC2573902)
2. Wang also invented a 3D portable cell sorter called magnetic sifter (MagSifter) which has been applied to enrich circulating tumor cells (CTCs) in lung cancer patients with unprecedented flow rates and nearly perfect capture yields (Cover article of LabChip, Jan., 2014). Very recently the MagSifter has been successfully combined with a Nanowell-based single cell analysis platform with in situ multiplex PCR capability, enabling single-CTC level analysis of molecular signature. This tool is shedding new insights into diagnosis, prognosis, and biology (e.g., mutation, metastasis, and remission) of lung cancer and other lethal diseases. More details can be found in the following publications:
   a. S. X. Wang, N. Pourmand, and R. L. White, "Magnetic sifter," *US Patent* No. 7,615,382; issued Nov. 10, 2009.
   b. C. M. Earhart, C. E. Hughes, R. S. Gaster, C. Ooi, R. J. Wilson, L. Y. Zhou, E. W. Humke, L. Xu, D. J. Wong, S. B. Willingham, E. J. Schwartz, I. L. Weissman, S. S. Jeffrey, J. W. Neal, R. Rohatgi, H. A. Wakelee, and S. X. Wang, "Isolation and mutational analysis of circulating tumor cells from lung cancer patients with magnetic sifters and biochips," *Lab on a Chip*, **14**, 78–88, 2014. (**Cover article**, Themed Issue on Circulating Tumor Cells) (PMCID: PMC4144998)

c. Seung-min Park, Dawson Wong, Chin Chun Ooi, Sanjiv Sam Gambhir, Shan X. Wang, Viswam S. Nair, "Molecular Analysis Using a Magnetic Sifter and Nanowell System," *US Patent Application* 15/133,996; filed April 20, 2016.
d. Seung-min Park, Dawson J. Wong, Chin Chun Ooi, David M. Kurtz, Ophir Vermesh, Amin Aalipour, Susie Suh, Kelsey L. Pian, Jacob J. Chabon, Sang Hun Lee, Mehran Jamali, Carmen Say, Justin N. Carter, Luke P. Lee, Ware G. Kuschner, Erich J. Schwartz, Joseph B. Shrager, Joel W. Neal, Heather A. Wakelee, Maximilian Diehn, Viswam S. Nair, Shan X. Wang, and Sanjiv S. Gambhir, "Molecular profiling of single circulating tumor cells from lung cancer patients," *Proc. Natl. Acad. Sci. (PNAS),* 113(52): E8379–E8386, 2016. (PMCID: PMC4237466)

3. Biomarker validation and clinical translation is a challenge to the biomedical community because vast majority of biomarkers discovered in research fail in clinical validation phase, the predicament of so called "valley of death". Wang group and collaborators are developing technologies and methods well suited for biomarker validation and clinical translation, including those for emerging mobile health applications. Wang Group's Eigen Diagnosis Platform won a distinguished award in Nokia Sensing XChallenge organized by the XPrize Foundation in 2014, and an Bold Epic Innovator Award in 2017. Immunity status against Hepatitis can be known in 10 min. with a cell phone App. Video at http://sensing.xprize.org/teams/competition-2-teams/eigen-lifescience. His lab also developed methods to rapidly screen antibody kinetic parameters and cross-reactivity for assay development, multiplex blood test for rapid triage of ionizing radiation exposure, and targeted molecular imaging agent.
   a. Jung-Rok Lee, Daniel J.B. Bechstein, Chin Chun Ooi, Ashka Patel, Richard S. Gaster, Elaine Ng, Lino C. Gonzalez, and Shan X. Wang, "Magneto-nanosensor platform for probing low-affinity protein-protein interactions and identification of a low-affinity PD-L1/PD-L2 interaction," *Nature Communications*, 7, 12220. (PMCID: PMC4961847)
   b. R. S. Gaster, L. Xu, S.-J. Han, R. J. Wilson, D. A. Hall, S. J. Osterfeld, H. Yu, and S. X. Wang, "Quantification of Protein Interactions and Solution Transport Using High-Density GMR Sensor Arrays," *Nature Nanotechnology*, 6, 314-320, 2011. (PMCID: PMC3089684)
   c. D. Kim, F. Marchetti, Z. Chen, S. Zaric, R. J. Wilson, D. A. Hall, R. S. Gaster, J.-R. Lee, J. Wang, S. J. Osterfeld, H. Yu, R. M. White, W. F. Blakely, L. Peterson, S. Bhatnagar, B. Manion, S. Tseng, K. Roth, M. Coleman, A. M. Snijders, A. J. Wyrobek, and S. X. Wang, "Nanosensor dosimetry of mouse blood proteins after exposure to ionizing radiation," *Scientific Reports*, **3**, 2234; DOI:10.1038/srep02234, 2013. (PMCID: PMC3715761)
   d. Fu A., Wilson R. J., Smith B. R., Wright J., Earhart C., Bales B., Guccione S., Wang S. X., Gambhir S. S. "Fluorescent Magnetic Nanoparticles for Magnetically Enhanced Cancer Imaging and Targeting in Living Subjects." *ACS Nano*, **6**, 6862-69, 2012. (PMCID: PMC3601027)

4. Wang and his collaborators also developed original chemical synthesis and/or physical fabrication recipes for monodisperse and uniform iron oxide nanoparticles, dumbbell-like multifunctional nanoparticles, and ultra-responsive antiferromagnetic nanoparticles, and magneto-fluorescent nanoparticles. These particles have been used widely in biosensing, imaging, cell sorting, water purification, catalysis, among others.
   a. S. Sun, H. Zeng, D. B. Robinson, S. Raoux, P. M. Rice, S. X. Wang, and G. Li, "Monodisperse MFe2O4 (M = Fe, Co, Mn) nanoparticles", *J. Am. Chem. Soc*., **126**, 273-279, 2004. (PMID: 14709092)
   b. H. Yu, M. Chen, P. M. Rice, S. X. Wang, R. L. White, and S. Sun, "Dumbbell-like bifunctional Au-Fe3O4 nanoparticles,". *Nano Lett*., **5**(2), 379-382, 2005. (PMID: 15794629)
   c. M. Zhang, X. Xie, M. Tang, C. S. Criddle, Y. Cui, S. X. Wang, "Magnetically ultra-responsive nanoscavengers for next-generation water purification systems," *Nature Communications*, **4**, 1866, 2013. (PMCID: PMC4123635)
   d. W. Cai, D.-W. Shin, K. Chen, O. Gheysens, Q. Cao, S. X. Wang, S. S. Gambhir, and X. Chen, "Peptide-labeled near-infrared quantum dots for imaging tumor vasculature in living subjects," *Nano Lett.* **6**(4), 669-76, 2006. (PMID: 16608262)

5. Wang was elected a Fellow of IEEE for extraordinary contributions to magnetic materials and device in 2009. Some of his non-biological research range from multiferroic materials, soft magnetic materials, spintronics, to magnetic information storage. The latter is at the physical foundation of Big Data and Cloud Computing. His representative publications in these areas are as follows, including a textbook on data storage:
   a. Y. H. Chu, L. W. Martin, M. B. Holcomb, M. Gajek, S-J. Han, Q. He, N. Balke, C.-H. Yang, D. Lee, W. Hu, Q. Zhan, P.-L. Yang, A. Fraile-Rodriguez, A. Scholl, S. X. Wang, and R. Ramesh, "Electric-field control of local ferromagnetism using a magnetoelectric multiferroic," *Nature Materials*, **7**, 478-412, 2008. (PMID: 18438412)

b. S. X. Wang, N. X. Sun, M. Yamaguchi, and S. Yabukami, "Properties of a new soft magnetic material," *Nature*, **407**, 150-1, Sept. 14, 2000. (PMID: 11001044)
c. M. Sharma, S. X. Wang, J. H. Nickel, “Inversion of spin polarization and tunneling magnetoresistance in spin-dependent tunneling junctions,” *Physical Review Letters* **82** (3), 616, 1999.
d. S. X. Wang and A. M. Taratorin, *Magnetic Information Storage Technology*, Academic Press, April, 1999.

***Complete List of My Published Work can be found in Google Scholar*:**
https://scholar.google.com/citations?user=BdTpqHQAAAAJ&hl=en

D. Research Support

Ongoing Research Support

U54CA199075-01 (Gambhir and Wang) 09/04/15 - 07/31/17
NIH/NCI
Center of Cancer Nanotechnology Excellence for Translational Diagnostics (CCNE-TD)
Three research projects and three cores are proposed. Project #1 focuses on the development of novel cancer triggered self-assembling and disassembling nanoparticles for photoacoustic and PET-MRI visualization of tumors, Project #2 focuses on the use of magneto-nanotechnology for blood proteomics, single cell sorting and comprehensive analyses. Project #3 focuses on molecular imaging of prostate cancer with nanobubbles for combined photoacoustic/ultrasound imaging as well as self-assembling nanoparticles for photoacoustic imaging.
Role: Co-PI

R01AI125197 (Utz and Wang) 08/01/16 – 07/31/21
NIH/NIAID
Giant MagnetoResistive (GMR) Sensors for Measuring Influenza Vaccine
The goal of this project is to identify predictive markers for outcomes of natural infection and/or vaccination with influenza markers that are perhaps applicable to other infectious agents. The Specific Aims are to: 1) Validate a panel of biomarkers for their ability to predict response to influenza vaccination and recovery from wild-type influenza virus infection; 2) Characterize biological pathways identified in Aim 1 using well-established and previously described patient cohorts, and to compare the existing biomarker datasets that are available; and 3) Develop a rapid, multiplexed assay for measuring transcripts using Giant MagnetoResistive (GMR) Sensors.
Role: Co-PI

1U19AI11049101 (Utz, PJ - Project 111592) 05/01/14 - 04/30/19
National Institutes of Health
ACE: Autoimmunity Center of Excellence (ACE) at Stanford
The main goal of the collaborative project within the ACE, in which Dr Wang is a co-investigator, is the apply GMR biosensor array to study multiple biomarkers in autoimmune diseases such as lupus.
Role: Co-I

Corporate Support (Wang) 07/01/12 - 12/31/17
Texas Instruments
Integrated Inductors and Sensors
The goal of the project is to create magnetic integrated inductors and sensors for the Internet of Things.
Role: PI

Completed Research Support

1R21CA18580401A1 (Wang) 12/01/14 - 11/30/16
National Institutes of Health
Analysis of CTCs for Early Prediction of Response to Treatment in RCC
We propose to use magnetic sifter to enrich circulating tumor cells (CTCs) from renal cell cancer patients to detect therapy response early.
Role: PI

5U01CA152737 (Gambhir) 09/21/10 - 06/30/16
National Institute of Health

New Tools for Prostate Cancer Detection and Prognostication
The major goal of this project is developing a biomarker panel on magneto-nanosensors for prostate cancer diagnosis/prognosis.
Role: Project Leader

U54CA151459 (Gambhir and Wang) 08/01/10 - 07/31/16
NIH/NCI
Center of Cancer Nanotechnology Excellence and Translation (CCNE-T)
Four research projects and three cores are proposed. Project #1 focuses on novel smart nanoparticles including Raman and self-assembling nanoparticles, Project #2 focuses on the use of magneto nanotechnology for blood proteomics and cell sorting. Project #3 focuses on the use of multiple nanoplatforms to interrogate single circulating tumor cells. Project #4 focuses on molecular imaging of ovarian cancer with photoacoustics and Raman nanoparticles, and monitoring response to therapy using imaging and magneto-nanosensors.
Role: Co-PI

U54CA143907 (Hillis and Agus) 09/01/09 - 08/31/14
National Cancer Institute
NCI Physical Science Oncology Center entitled “Multi-scale Complex Systems Transdisciplinary Analysis of Response to Therapy (MC-START)”.
The Center is focused on multi-scale measurement and modeling to allow specific cases of cancer to be modeled with sufficient fidelity to estimate the relative probable efficacy of alternative therapies.
Role: Project 4 Co-Leader

R33CA138330 (Wang and Wakelee) 04/01/10 - 03/31/13
National Cancer Institute
Cancer Sample Preparation with Micromachined Magnetic Sifter and Nanoparticles
This project is aimed at developing micromachined magnetic sifters and novel synthetic antiferromagnetic nanoparticles for efficiently capturing and enriching protein tumor targets and rare cells.
Role: PI

SBIR Subaward (Wang - Project 118561) 11/01/14 - 02/28/15
Prime Sponsor: Centers for Disease Control
Ocean Nano Tech, LLC
Magneto-Nanosensor for Detection of Serum Biomarkers Associated with Hepatocellular Cancer
We aim to develop a blood-based protein biomarker panel for heptacellular cancer diagnosis.
Role: Subaward PI