



## James Harris

James and Elenor Chesebrough Professor in the School of Engineering,  
Emeritus

Electrical Engineering

 NIH Biosketch available Online

 Curriculum Vitae available Online

### Bio

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#### BIO

Harris utilizes molecular beam epitaxy (MBE) of III-V compound semiconductor materials to investigate new materials for electronic and optoelectronic devices. He utilizes heterojunctions, superlattices, quantum wells, and three-dimensional self-assembled quantum dots to create metastable engineered materials with novel or improved properties for electronic and optoelectronic devices. His early work in the 1970's demonstrating a practical heterojunction bipolar transistor led to their application in every mobile phone today and record setting solar cell efficiency. He has recently focused on three areas: 1) integration of photonic devices and micro optics for creation of new minimally invasive bio and medical systems for micro-array and neural imaging and 2) application of nanostructures semiconductors for the acceleration of electrons using light, a dielectric Laser Accelerator (DLA), and 3) novel materials and nano structuring for high efficiency solar cells and photo electrochemical water splitting for the generation of hydrogen.

#### ACADEMIC APPOINTMENTS

- Professor Emeritus, Electrical Engineering
- Member, Bio-X
- Affiliate, Precourt Institute for Energy
- Affiliate, Stanford Woods Institute for the Environment
- Member, Wu Tsai Neurosciences Institute

#### HONORS AND AWARDS

- Jun-ichi Nishizawa Medal, IEEE (2023)
- Elected Member, National Academy of Engineering (2011)
- Aristotle Award, Semiconductor Research Corporation (2013)
- AI Cho MBE Award, International MBE Conference (2014)
- MBE Innovator Award, International MBE Conference (2008)
- Alexander Humboldt Senior Research Prize, Alexander Humboldt (1999)
- Morris Liebmann Award, IEEE (2000)
- Welker Medal, International Symposium on Compound Semiconductors (2000)
- Fellow, IEEE (1988)
- Fellow, American Physical Society (1992)
- Fellow, Optical Society of America (2005)
- Fellow, Materials Research Society (2009)

## PROFESSIONAL EDUCATION

- PhD, Stanford University , Electrical Engineering (1969)
- MS, Stanford University , Electrical Engineering (1965)
- BS, Stanford University , Electrical Engineering (1964)

## LINKS

- <http://www-ee.stanford.edu/~harris>: <http://www-ee.stanford.edu/~harris>

## Research & Scholarship

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### CURRENT RESEARCH AND SCHOLARLY INTERESTS

Research interests have been in the areas of new electronic and optoelectronic device structures created by heterojunctions, quantum wells, superlattices and nanostructured materials. Molecular Beam Epitaxy (MBE) has been the foundation to prepare nanostructured metastable materials with atomic layer control and dimensions smaller than the wavelength of electrons. In this regime, quantum size effects can be utilized to create entirely new device structures based upon tailored transitions between quantum states and tunneling between states and structures. Past two decades focused on MBE growth of novel optoelectronic materials (GaInNAsSb) for long wavelength lasers and solar cells; quantum well structures for surface emitting lasers with power and bandwidth demands of AI now driving 10,000 element VCSEL arrays for optical interconnect; integrated nanophotonic structures for laser driven dielectric electron accelerators and free electron lasers (FEL) on a wafer for medical imaging systems; high speed optical modulators and non-linear optical effects for generation, control and application of ultra-short optical pulses; ultra-high efficiency multi-bandgap solar cells; world record solar to hydrogen conversion with water splitting; Si based photonic devices, including single photon avalanche detector (SPAD) for range finding and autonomous vehicles; implantable retina prosthesis with first human response in phase 1 human trials, 12/17.

## Teaching

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### STANFORD ADVISEES

#### Doctoral Dissertation Reader (AC)

Jeongkyu Kim, Devansh Saraswat

## Publications

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### PUBLICATIONS

- **Vertical-junction photodiodes for smaller pixels in retinal prostheses.** *Journal of neural engineering*  
Huang, T. W., Kamins, T. n., Chen, Z. C., Wang, B. Y., Bhuckory, M. n., Galambos, L. n., Ho, E. n., Ling, T. n., Afshar, S. n., Shin, A. n., Zuckerman, V. n., Harris, J. S., Mathieson, et al  
2021
- **A miniaturized optoelectronic biosensor for real-time point-of-care total protein analysis.** *MethodsX*  
Vermesh, O., Mahzabeen, F., Levi, J., Tan, M., Alam, I. S., Chan, C. T., Gambhir, S. S., Harris, J. S.  
2021; 8: 101414
- **Low loss Gallium Oxide core/Silica cladding planar waveguide**  
Tan, S., Deng, H., Urbanek, K., Miao, Y., Zhao, Z., Harris, J. S., Byer, R. L., IEEE  
IEEE.2021
- **Novel Materials-based Laser Acceleration**  
Deng, H., Leedle, K. J., Miao, Y., Black, D. S., Urbanek, K., McNeur, J., Kozak, M., Ceballos, A., Hommelhoff, P., Solgaard, O., Byer, R. L., Harris, J. S., IEEE  
IEEE.2021

- **Real-time point-of-care total protein measurement with a miniaturized optoelectronic biosensor and fast fluorescence-based assay.** *Biosensors & bioelectronics*  
Mahzabeen, F., Vermesh, O., Levi, J., Tan, M., Alam, I. S., Chan, C. T., Gambhir, S. S., Harris, J. S.  
2020: 112823
- **Growth mode control for direct-gap core/shell Ge/GeSn nanowire light emission** *MATERIALS TODAY*  
Meng, A. C., Braun, M. R., Wang, Y., Peng, S., Tan, W., Lentz, J., Xue, M., Pakzad, A., Marshall, A. F., Harris, J. S., Cai, W., McIntyre, P. C.  
2020; 40: 101–13
- **Free-standing 2.7  $\mu\text{m}$  thick ultrathin crystalline silicon solar cell with efficiency above 12.0% (vol 70, 104466, 2020)** *NANO ENERGY*  
Xue, M., Nazif, K., Lyu, Z., Jiang, J., Lu, C., Lee, N., Zang, K., Chen, Y., Zheng, T., Kamins, T. I., Brongersma, M. L., Saraswat, K. C., Harris, et al  
2020; 72
- **Low-loss GaOx-core/SiO2-cladding planar waveguides on Si substrate** *OPTICS EXPRESS*  
Tan, S., Deng, H., Urbaneek, K. E., Miao, Y., Zhao, Z., Harris, J. S., Byer, R. L.  
2020; 28 (8): 12475–86
- **Free-standing 2.7  $\mu\text{m}$  thick ultrathin crystalline silicon solar cell with efficiency above 12.0%** *NANO ENERGY*  
Xue, M., Nazif, K., Lyu, Z., Jiang, J., Lu, C., Lee, N., Zang, K., Chen, Y., Zheng, T., Kamins, T., Brongersma, M. L., Saraswat, K. C., Harris, et al  
2020; 70
- **Gallium Oxide for High-Power Optical Applications** *ADVANCED OPTICAL MATERIALS*  
Deng, H., Leedle, K. J., Miao, Y., Black, D. S., Urbaneek, K. E., McNeur, J., Kozak, M., Ceballos, A., Hommelhoff, P., Solgaard, O., Byer, R. L., Harris, J. S.  
2020
- **Surface treatments of dielectric laser accelerators for increased laser-induced damage threshold** *OPTICS LETTERS*  
Miao, Y., Black, D. S., Leedle, K. J., Zhao, Z., Deng, H., Ceballos, A., Byer, R. L., Harris, J. S., Solgaard, O.  
2020; 45 (2): 391–94
- **Silicon nitride waveguide as a power delivery component for dielectric laser accelerators**  
Zhao, Z., Tan, S., Urbaneek, K., Hughes, T., Lee, Y., Fan, S., Harris, J. S., Byer, R. L., IEEE  
IEEE.2020
- **Titanium Dioxide Hole-Blocking Layer in Ultra-Thin-Film Crystalline Silicon Solar Cells** *IEEE PHOTONICS JOURNAL*  
Kang, Y., Deng, H., Chen, Y., Huo, Y., Jia, J., Zhao, L., Zaidi, Z., Zang, K., Harris, J. S.  
2019; 11 (6)
- **Continuous-Wave Operation of GaAs-Based 1.5- $\mu\text{m}$  GaInNAsSb VCSELs** *IEEE PHOTONICS TECHNOLOGY LETTERS*  
Sarmiento, T., Zhao, L., Moser, P., Li, T., Huo, Y., Harris, J. S.  
2019; 31 (20): 1607–10
- **Characteristics of prosthetic vision in rats with subretinal flat and pillar electrode arrays.** *Journal of neural engineering*  
Ho, E., Lei, X., Flores, T. A., Lorach, H., Huang, T. W., Galambos, L., Kamins, T., Harris, J. S., Mathieson, K., Palanker, D.  
2019
- **Strain-Induced Enhancement of Electroluminescence from Highly Strained Germanium Light-Emitting Diodes** *ACS PHOTONICS*  
Jiang, J., Xue, M., Lu, C., Fenrich, C. S., Morea, M., Zang, K., Gao, J., Cheng, M., Zhang, Y., Kamins, T. I., Harris, J. S., Sun, J.  
2019; 6 (4): 915–23
- **Improving characterization capabilities in new single-photon avalanche diode research** *REVIEW OF SCIENTIFIC INSTRUMENTS*  
Ding, X., Zang, K., Zheng, T., Fei, Y., Huang, M., Liu, X., Wang, Y., Jin, G., Huo, Y., Harris, J. S., Jiang, X.  
2019; 90 (4)
- **Silicon nitride waveguide as a power delivery component for on-chip dielectric laser accelerators** *OPTICS LETTERS*  
Tan, S., Zhao, Z., Urbaneek, K., Hughes, T., Lee, Y., Fan, S., Harris, J. S., Byer, R. L.  
2019; 44 (2): 335–38
- **Improving characterization capabilities in new single-photon avalanche diode research.** *The Review of scientific instruments*  
Ding, X. n., Zang, K. n., Zheng, T. n., Fei, Y. n., Huang, M. n., Liu, X. n., Wang, Y. n., Jin, G. n., Huo, Y. n., Harris, J. S., Jiang, X. n.

2019; 90 (4): 043108

- **Design of a tapered slot waveguide dielectric laser accelerator for sub-relativistic electrons**  
Zhao, Z., Hughes, T. W., Tan, S., Deng, H., Sapra, N., England, R., Vuckovic, J., Harris, J. S., Byer, R. L., Fan, S., IEEE  
IEEE.2019
- **Integrated photonics for NASA applications**  
Krainak, M., Stephen, M., Troupaki, E., Tedder, S., Reyna, B., Klamkin, J., Zhao, H., Song, B., Fridlander, J., Minh Tran, Bowers, J. E., Bergman, K., Lipson, M., et al  
edited by Glebov, A. L., Leisher, P. O.  
SPIE-INT SOC OPTICAL ENGINEERING.2019
- **Electrically Tunable, CMOS-Compatible Metamaterial Based on Semiconductor Nanopillars** *ACS PHOTONICS*  
Morea, M., Zang, K., Kamins, T. I., Brongersma, M. L., Harris, J. S.  
2018; 5 (11): 4702–9
- **Epsilon-Near-Zero Si Slot-Waveguide Modulator** *ACS PHOTONICS*  
Liu, X., Zang, K., Kang, J., Park, J., Harris, J. S., Kik, P. G., Brongersma, M. L.  
2018; 5 (11): 4484–90
- **Design of a tapered slot waveguide dielectric laser accelerator for sub-relativistic electrons** *OPTICS EXPRESS*  
Zhao, Z., Hughes, T. W., Tan, S., Deng, H., Sapra, N., England, R., Vuckovic, J., Harris, J. S., Byer, R. L., Fan, S.  
2018; 26 (18): 22801–15
- **Elements of a dielectric laser accelerator** *OPTICA*  
McNeur, J., Kozak, M., Schoenenberger, N., Leedle, K. J., Deng, H., Ceballos, A., Hoogland, H., Ruehl, A., Hartl, I., Holzwarth, R., Solgaard, O., Harris, J. S., Byer, et al  
2018; 5 (6): 687–90
- **Pile-up correction in characterizing single-photon avalanche diodes of high dark count rate** *OPTICAL AND QUANTUM ELECTRONICS*  
Ding, X., Zang, K., Fei, Y., Zheng, T., Su, T., Morea, M., Jin, G., Harris, J. S., Jiang, X., Zhang, Q.  
2018; 50 (6)
- **On-Chip Laser-Power Delivery System for Dielectric Laser Accelerators** *PHYSICAL REVIEW APPLIED*  
Hughes, T. W., Tan, S., Zhao, Z., Sapra, N. V., Leedle, K. J., Deng, H., Miao, Y., Black, D. S., Solgaard, O., Harris, J. S., Vuckovic, J., Byer, R. L., Fan, et al  
2018; 9 (5)
- **Phase-dependent laser acceleration of electrons with symmetrically driven silicon dual pillar gratings** *OPTICS LETTERS*  
Leedle, K. J., Black, D. S., Miao, Y., Urbanek, K. E., Ceballos, A., Deng, H., Harris, J. S., Solgaard, O., Byer, R. L.  
2018; 43 (9): 2181–84
- **Carrier-selective interlayer materials for silicon solar cell contacts** *JOURNAL OF APPLIED PHYSICS*  
Xue, M., Islam, R., Chen, Y., Chen, J., Lu, C., Pleus, A., Tae, C., Xu, K., Liu, Y., Kamins, T. I., Saraswat, K. C., Harris, J. S.  
2018; 123 (14)
- **Spatiotemporal characteristics of retinal response to network-mediated photovoltaic stimulation** *JOURNAL OF NEUROPHYSIOLOGY*  
Ho, E., Smith, R., Goetz, G., Lei, X., Galambos, L., Kamins, T. I., Harris, J., Mathieson, K., Palanker, D., Sher, A.  
2018; 119 (2): 389–400
- **Electrical and optical 3D modelling of light-trapping single-photon avalanche diode**  
Zheng, T., Zang, K., Morea, M., Xue, M., Lu, C., Jiang, X., Zhang, Q., Kamins, T. I., Harris, J. S.  
edited by Witzigmann, B., Osinski, M., Arakawa, Y.  
SPIE-INT SOC OPTICAL ENGINEERING.2018
- **NASA Integrated Photonics**  
Krainak, M., Stephen, M., Klamkin, J., Bergman, K., Lipson, M., Mookherjea, S., Lesiher, P., Ho, S., Moslehi, B., Harris, J., Matsko, A., Savchenkov, A., Yoo, et al  
edited by Winzer, P., Tsang, H. K., Capmany, J., Yao, J., Fontaine, N., Dutta, N.  
IEEE.2018

- **Investigation of Nickel Oxide as Carrier-selective Interlayer for Silicon Solar Cell Contacts**  
Xue, M., Islam, R., Chen, Y., Lu, C., Lyu, Z., Zang, K., Jia, J., Deng, H., Kamins, T., Saraswat, K., Harris, J., IEEE  
IEEE.2018: 2180–82
- **Comprehensive modeling on luminescent coupling dependency in multi-junction solar cells**  
Sun, Z., Lyu, Z., Jia, J., Xue, M., Chen, K., Fang, S., Harris, J. S.  
edited by Witzigmann, B., Osinski, M., Arakawa, Y.  
SPIE-INT SOC OPTICAL ENGINEERING.2018
- **Contact Selectivity Engineering in a 2 μm Thick Ultrathin c-Si Solar Cell Using Transition-Metal Oxides Achieving an Efficiency of 10.8.** *ACS applied materials & interfaces*  
Xue, M., Islam, R., Meng, A. C., Lyu, Z., Lu, C., Tae, C., Braun, M. R., Zang, K., McIntyre, P. C., Kamins, T. I., Saraswat, K. C., Harris, J. S.  
2017
- **First-principle Study for More Accurate Optical and Electrical Characterization of Ge<sub>1-x</sub>Sn<sub>x</sub> Alloy for Si and Group-IV Device Applications** *JOURNAL OF SEMICONDUCTOR TECHNOLOGY AND SCIENCE*  
Cho, Y., Cho, S., Park, B., Harris, J. S.  
2017; 17 (5): 675–84
- **Silicon single-photon avalanche diodes with nano-structured light trapping** *NATURE COMMUNICATIONS*  
Zang, K., Jiang, X., Huo, Y., Ding, X., Morea, M., Chen, X., Lu, C., Ma, J., Zhou, M., Xia, Z., Yu, Z., Kamins, T. I., Zhang, et al  
2017; 8: 628
- **Passivation of multiple-quantum-well Ge<sub>0.97</sub>Sn<sub>0.03</sub>/Ge p-i-n photodetectors** *APPLIED PHYSICS LETTERS*  
Morea, M., Brendel, C. E., Zang, K., Suh, J., Fenrich, C. S., Huang, Y., Chung, H., Huo, Y., Kamins, T. I., Saraswat, K. C., Harris, J. S.  
2017; 110 (9)
- **Multifunctional, inexpensive, and reusable nanoparticle-printed biochip for cell manipulation and diagnosis.** *Proceedings of the National Academy of Sciences of the United States of America*  
Esfandyarpour, R., DiDonato, M. J., Yang, Y., Durmus, N. G., Harris, J. S., Davis, R. W.  
2017; 114 (8): E1306-E1315
- **Sub-optical-cycle control of free electrons by optical near-fields**  
Kozak, M., McNeur, J., Leedle, K. J., Deng, H., Schoenenberger, N., Ruehl, A., Hartl, I., Harris, J. S., Byer, R. L., Hommelhoff, P., IEEE  
IEEE.2017
- **Nanostructured Dielectric Layer for Ultrathin Crystalline Silicon Solar Cells** *INTERNATIONAL JOURNAL OF PHOTOENERGY*  
Chen, Y., Kang, Y., Jia, J., Huo, Y., Xue, M., Lyu, Z., Liang, D., Zhao, L., Harris, J. S.  
2017
- **Ge/SiGe Quantum-well Micro-bridges with High Tensile Strain**  
Xue, M., Chen, X., Chen, J., Kao, M., Shang, C., Zang, K., Huo, Y., Lu, C., Chen, Y., Deng, H., Kamins, T. I., Harris, J. S., IEEE  
IEEE.2017
- **Simulations of Taper Designs for Integrated Ge/SiGe Waveguide System**  
Lu, C., Zang, K., Huo, Y., Chen, X., Fei, E. T., Xue, M., Kamins, T. I., Harris, J. S., IEEE  
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- **Surface textured silicon single-photon avalanche diode**  
Zang, K., Ding, X., Jiang, X., Huo, Y., Morea, M., Chen, X., Lu, C., Xue, M., Chen, Y., Shang, C., Kamins, T. I., Zhang, Q., Pan, et al  
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- **Tensile-strained Ge/SiGe multiple quantum well microdisks** *Photonics Research*  
Chen, X., Fenrich, C. S., Xue, M., Kao, M., Zang, K., Lu, C., Fei, E. T., Chen, Y., Huo, Y., Kamins, T. I., Harris, J. S.  
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- **Strained Pseudomorphic Ge<sub>1-x</sub>Sn<sub>x</sub> Multiple Quantum Well Microdisk Using SiNy Stressor Layer** *ACS PHOTONICS*  
Fenrich, C. S., Chen, X., Chen, R., Huang, Y., Chung, H., Kao, M., Huo, Y., Kamins, T. I., Harris, J. S.  
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- **Core-Shell Germanium/Germanium Tin Nanowires Exhibiting Room Temperature Direct- and Indirect-Gap Photoluminescence** *NANO LETTERS*  
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- **SiC protective coating for photovoltaic retinal prosthesis.** *Journal of neural engineering*  
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2016; 13 (4): 046016-?
- **Analysis of luminescent coupling effects in n series-connected multijunction solar cells** *PHYSICA STATUS SOLIDI A-APPLICATIONS AND MATERIALS SCIENCE*  
Mazouchi, M., Jia, J., Huo, Y., Miao, Y., Kang, Y., Chen, Y., Harris, J. S., Dutta, M.  
2016; 213 (4): 941-946
- **Dry-wet digital etching of Ge<sub>1-x</sub>Sn<sub>x</sub>** *APPLIED PHYSICS LETTERS*  
Shang, C. K., Wang, V., Chen, R., Gupta, S., Huang, Y., Pao, J. J., Huo, Y., Sanchez, E., Kim, Y., Kamins, T. I., Harris, J. S.  
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- **Nanoelectronic three-dimensional (3D) nanotip sensing array for real-time, sensitive, label-free sequence specific detection of nucleic acids.** *Biomedical microdevices*  
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- **Photovoltaic Pixels for Neural Stimulation: Circuit Models and Performance.** *IEEE transactions on biomedical circuits and systems*  
Boinagrov, D., Lei, X., Goetz, G., Kamins, T. I., Mathieson, K., Galambos, L., Harris, J. S., Palanker, D.  
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- **Interactions of Prosthetic and Natural Vision in Animals With Local Retinal Degeneration** *INVESTIGATIVE OPHTHALMOLOGY & VISUAL SCIENCE*  
Lorach, H., Lei, X., Galambos, L., Kamins, T., Mathieson, K., Dalal, R., Huie, P., Harris, J., Palanker, D.  
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- **On-chip plasmonic waveguide optical waveplate.** *Scientific reports*  
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- **Dielectric laser acceleration of sub-100 keV electrons with silicon dual-pillar grating structures** *OPTICS LETTERS*  
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- **Performance of photovoltaic arrays in-vivo and characteristics of prosthetic vision in animals with retinal degeneration** *VISION RESEARCH*  
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- **Photovoltaic restoration of sight with high visual acuity** *NATURE MEDICINE*  
Lorach, H., Goetz, G., Smith, R., Lei, X., Mandel, Y., Kamins, T., Mathieson, K., Huie, P., Harris, J., Sher, A., Palanker, D.  
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Leedle, K. J., Pease, R. F., Byer, R. L., Harris, J. S.  
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Kang, Y., Liang, D., Mehra, S., Huo, Y., Chen, Y., Christoforo, M. G., Salleo, A., Harris, J. S.  
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2015; 5: 15794-?
- **Photovoltaic Restoration of Sight with High Visual Acuity in Rats with Retinal Degeneration** *25th Conference on Ophthalmic Technologies held as a part of the SPIE Photonics West BIOS Meeting*  
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SPIE-INT SOC OPTICAL ENGINEERING.2015
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