Prof. Yue Kuo (http://yuekuo.tamu.edu)

Dr. Yue Kuo is Dow Professor Chemical Engineering with a joint appointment in Electrical Engineering and Materials Science and Engineering, Texas A&M University where he established the renowned Thin Film Nano & Microelectronics Research Laboratory. He received B.S. (1974) from National Taiwan University and M.S. (1978) and Dr. Eng. Sci. (1979) from Columbia University.

Prof. Kuo is one of the few semiconductor experts who have extensive hands-on production and R&D experience in thin film transistors (TFTs) for LCDs and ICs industries with a distinguished track record. He spent about 20 years at IBM T. J. Watson Research Center, Yorktown Heights, NY, Semiconductor Division of Data General in Silicon Valley, etc., as well as 17 years at Texas A&M University.

Due to distinguished contributions to science, technology, and leadership, Prof. Kuo was honored with Gordon E. Moore Medal of Solid State Science and Technology (an ECS biannual award), Fellow of IEEE, Fellow of Electrochemical Society, Fellow of Texas Engineering Experiment Station, ECS Electronics and Photonics award, Distinguished Research Achievement Award of Texas A&M University, Innovation Award of Texas A&M University System, 10 IBM awards, honorary professorships, 160 plenary, keynote, and invited speeches in international conferences, universities, and R&D centers, numerous best/most downloaded/highlighted/awarded papers, etc. He served on advisory and review boards, and panels for US National Academies, industry, universities, and governments. He was consulted by the late Prime Minister of Taiwan Mr. Sun, Yuen-Hsien in establishing the $100M national R&D project on TFT LCDs, which set up the foundation of today's multibillion dollar industry.

Prof. Kuo is a recognized expert in the interdisciplinary nano and microelectronics area with emphasis on understanding the complicated relationship among device performance, material properties, and fabrication processes. His research has resulted in many world records and posed great impacts to both academia and industry. For example,

- His 2-photomask TFT fabrication process is the simplest method and has been widely used in university and industry laboratories for device, circuit, and material studies.
- His discovery of the plasma etch induced radiation damages to the a-Si:H TFT and repair method have been critical to the worldwide panel production.
- His theory on the generalized material-process-device relationship is the most widely-used guideline in starting new TFT LCD production lines.
- He was the first to report a practical n^+ a-Si:H to intrinsic a-Si:H RIE process that is critical to the bilayer TFT production.
- His novel plasma-based, room-temperature copper etch process has solved a 50-year old semiconductor production problem and has been used LCD and IC chips.
- His work on TFT-driven microchannel biochips for DNA and protein identification has been selected to the prestigious *APS Virt. J.* (3 times) and other honors.
- He invented many new TFT structures to improve the transistor performance and to solve the light sensitivity and yield problems.
- He is the first to report the a-Si:H embedded floating-gate a-Si:H TFT nonvolatile memory device, which is critical to future multifunctional LCDs.
- His novel idea of comparing and possible merging ULSIC and TFT technologies has created enormous interests and caused vigorous discussions in communities.

Prof. Kuo has made major contributions on many ICs and high-*k* topics. For example

- He was the first to present the concept of using the doping method to break the thermodynamic limit on preparing nm-thin amorphous high-*k* dielectrics.
- He first demonstrated the possibility of storing holes and electrons separately by embedding selected nanocrystals in the high-*k* film with physical interpretation.
- He invented the novel solid state incandescent LED (SSI-LED) that is a solid state Edison-style light bulb analogous to the transformation of the vacuum tube triode to the solid state transistor. This single-chip, white-light device has a long lifetime of > 20,000 hours and was fabricated with IC compatible materials and process. The first paper in *APL* was downloaded 1,000 times within 2 weeks of publication and highlighted in *IEEE IEDM*, *IEEE Spectrum*, *J. Vac. Sci. Tech.*, and other publications.
- He first reported a new type of antifuse-diode device that can be used in memory and switching applications in IC and other electronic products.
- He was the first to present the perception of combining ULSIC and TFT fields into one area based on the common solid state physics, thin film materials, and processes.

Prof. Kuo has authored more than 400 papers, holds 11 patents and more than 40 inventions on TFTs, solid state devices, structures and fabrication processes. Many of his papers have been mostly cited, downloaded, highlighted, key selection, cover page, etc. articles with honors, such as the #1 and #4 most cited papers (as of March 2013) in *ECS Trans.*, *Jpn. J. Appl. Phys.*, *J. Vac. Sci. Technol. B*, *J. Appl. Phys.*, *Appl. Phys. Lett.*, *Microelectronics Reliability*, *AIP/APS Virtual J. Nanoscale Sci. and Technol.*, *Virtual J. Biological Phys.* (7 times), *IIE Trans.*, *IEEE Spectrum*, and *IEEE EDS News Letters*. In addition, he edited 30 journals and conference proceedings, two TFT textbooks, and 3 short course books. His Amorphous and Polycrystalline Silicon TFT books (Kluwer, 2004) have been the classic textbooks widely used in universities and industry. His research results and inventions have been used in worldwide productions. They are often quoted in semiconductor magazines and news media.

Prof. Kuo has served in various positions in professional societies, such as Vice President of ECS, board of directors, award committees, editorial boards, symposium organizers, chairs, etc. He has also organized, chaired, and co-chaired over 90 international conferences on TFTs, ICs, thin films, and plasma technology sponsored by IEEE, ECS, MRS, AVS, Jpn. Soc. Appl. Phys., ECI, SID, etc. He has been the founder and key organizer of the world longest, continuously held TFT symposium series for 26 years. His ULSIC vs. TFT international conference is celebrating the 10th year anniversary in 2015. He has consulted for semiconductor companies and advised PhD students in American, European, and Asian universities.

Prof. Kuo's Thin Film Nano & Microelectronics Research Laboratory is dedicated to interdisciplinary research and education. This laboratory is not only an incubator for training young talents but also a powerhouse for hosting well-attended seminars delivered by leading researchers. Over 47 PhD/MS students and postdoctoral/visiting researchers have graduated from this laboratory. Over 3,000 audiences have attended seminars sponsored by this laboratory. He has been active in science extension programs in educating engineers, K12, and minority students. He has delivered review speeches and short courses in professional societies.

In summary, Prof. Kuo is an outstanding researcher, a distinguished technology leader, and a highly established educator on nano science and technology whose work has greatly contributed to the success of industry.

Curriculum Vitae

Yue Kuo
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CURRICULUM VITAE

YUE KUO

January 2016

1. ADDRESS 235 J. E. Brown Engineering Building, MS 3122
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2. PERSONAL Married, U.S. Citizen

3. RESEARCH Nano and microelectronics devices, TFTs, ICs, thin film materials, fabrication processes, plasma technology, and applications.

4. EXPERIENCE

5/15- 5/18 Vice President, Electrochemical Society, Pennington, NJ

12/09 Honorary Professor, Shanghai Jiaotong University, China
Honorary Professor, Nankai University, Tianjin, China
Honorary Professor, Xian Jiaotong University, China

4/98 - Present Dow Professor, Thin Film Nano & Microelectronics Research Lab
Chemical Engineering, Electrical Eng., Materials Science & Eng.
Texas A&M University, College Station, TX

Recipient of Gordon E. Moore Medal for outstanding achievement in solid state science and technology, ECS 2015.

1. Thin-film transistors (TFTs).
This research is focused on thin film materials, fabrication processes, for novel TFT applications, such as the floating-gate a-Si:H TFT nonvolatile memories, space radiation damage to the a-Si:H TFT, bipolar a-Si:H TFTs, CMOS-type a-Si:H TFTs with complete copper electrodes, reliability of TFTs on flexible substrates, and TFT-based biosensors. We further explored the broad picture of the semiconductor technology from fundamental material, process, and device point-of-view. We invented the floating-gate a-Si:H TFT nonvolatile memories for the low temperature substrate applications. Also, we first presented the concept of merging of TFT and ULSIC technologies. The paper on this topic was selected a Top 10 most downloaded paper in *Jpn. J. Appl. Phys.* in 2008 as well as in the prestigious *AIP/APS Virtual J. Nanoscale Sci. and Technol.* Five international conferences have been held on this subject.
The first comprehensive 2-volume TFT textbook was published. It has been widely used as the textbook in universities and a reference in industry. It was translated into a foreign copy was within one year.

2. ULSIC technology and nonvolatile memory devices.
This research has been focused on exploring new materials, device

structures, and reliability physics to advance the ULSIC technology. For example, the ultra-low EOT high-*k* gate dielectrics, nanocrystals embedded nonvolatile memories, antifuse, ultra low *k* dielectrics, life extension of polymeric pellicles, etc. have been investigated. The concept of using the doping method to break the thermodynamic limits on the high-*k* dielectric's interface and bulk properties was presented and studied. The sub 1 nm EOT thick Zr-doped HfO_2 high-*k* film with excellent electrical characteristics was achieved. One of his papers has been selected as a top 20 most downloaded paper in *J. Vac. Sci. Technol. B* in May 2013. Separately, the nanocrystals embedded high-*k* nonvolatile memory papers were 3 times selected to appear in the prestigious AIP/APS *Virtual J. Nanoscale Sci. and Technol.* The high-*k* reliability paper was selected as a Top 25 Hottest paper in *Microelectronics and Reliability J.* and a Key Article in *IIE Trans. Special Issue on Quality and Design Issues in Nanomafacturing Systems*. In addition, the 2-step breakdown process of the ultra thin high-*k* stack and the mechanism were studied using the novel ramp-relax method. Also, the hole-trapping memory devices based on nanocrystalline ITO or MoO_x embedded high-*k* thin films were discovered, which greatly expanded the memory functions of the ULSICs. His papers have been ranked #1 and #4 most cited papers in the *ECS Transactions* history as to March 2013.
A novel super low k, i.e., < 2, polyimide film was achieved by the hydrogenation plasma modification method due to change of chemical bonds and physical structures. This is an important backend process.
An ultra thin film, i.e., 5 nm thick, passivation layer was sputter deposited on the polymeric 157 nm and 193 nm pellicles to extend their lifetimes. The early failure of the pellicle was prevented due to the drastic improvement of the heat dissipation rate across the surface. The environmental resistance was also improved with this method.

3. Plasma thin film technology.
A novel plasma-based room-temperature copper etch process was invented and extensively investigated, which is a breakthrough of the semiconductor fabrication history. According to an industry executive, this is a disruptive technology. The result has been cited in news media, e.g., *Semiconductor International* (02/02), *Electronic News* (04/01/02), etc. It has been a case study subject of several MBA programs. The reliability of the etched fine line was further investigated for ICs, displays, and flexible electronics applications. This process has been used in LG's 15-inch flat panel displays and TI's BiCMOS chips. One of his recent papers on electromigration of the etched copper lines on steps was selected in the *J. Appl. Phys. Research Highlights and News* (April 2012) and a *Top 20 Most Read Articles* in this issue.
Additionally, fundamental studies on material, electrical, and optical properties of sub 100ºC PECVD a-Si:H, n^+, p^+, and SiN_x thin films were carried out. These films were fabricated into transistors, sensors,

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