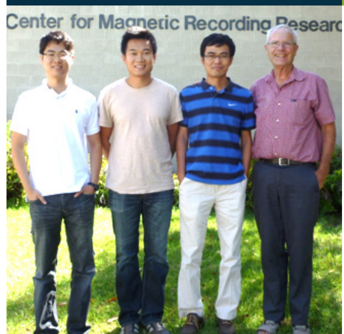


Best Paper at ASME

The 23rd ASME Annual Conference on Information Storage and Process Systems (ISPS 2014) presented the Best Paper Award – ISPS 2014 Certificate to Chuanwei Zhang, Young Woo Seo, Alex Phan, and Professor Frank Talke! The award was for their paper titled, "Effect of a Disk Asperity and a Void on the Heat Transfer in the Head Disk Interface." The recipients of this Tribology, Head/Media Interface Track Paper Award were recognized for their academic and research excellence achieved in the field of data storage.

SELECTED PAPERS AND TALKS

Professor Raymond de Callafon

H. Fang, X. Zhao, Y. Wang, Z. Sahinoglu, T. Wada, S. Hara and **R.A. de Callafon**. "Improved adaptive state-of-charge estimation for batteries using a multi-model approach." Journal of Power Sources 254, May 2014

Professor Eric E. Fullerton

D. B. Gopman, D. Bedau, S. Mangin, **E. E. Fullerton**, J. A. Katine and A. D. Kent. "Switching field distributions with spin transfer torques in perpendicularly magnetized spin-valve nanopillars," Physical Review B, Vol. 89, No. 13, April 28, 2014.

Y. Choi, D. J. Keavney, M. V. Holt, V. Uhlíř, D. Arena, **E. E. Fullerton**, P. J. Ryan, and J-W. Kim. "Critical phenomena of nano phase evolution in a first order transition," arXiv preprint arXiv:1405.4319,May 16, 2014.

H. Liu, D. Bedau, J. Z. Sun, S. Mangin, **E. E. Fullerton**, J. A. Katine and A. D. Kent. "Dynamics of spin torque switching in all-perpendicular spin valve nanopillars," Journal of Magnetism and Magnetic Materials, May 31, 2014.

M. Kuteifan, M. V. Lubarda, S. Fu, R. Chang, M. A. Escobar, S. Mangin, **E. E. Fullerton** and **V. Lomakin**. "Large exchange-dominated domain wall velocities in antiferromagnetically coupled nanowires," arXiv preprint arXiv:1406.3253, June 12, 2014.

D. Lu, L. Ferrari, J. J. Kan, **E. E. Fullerton** and Z. Liu. "Nanopatterned Multilayer Hyperbolic Metamaterials for Enhancing Spontaneous Light Emission." CLEO: QELS_Fundamental Science, pp. FW1C-2. Optical Society of America, June 2014.

F. Pressacco, E. Mancini, V. Uhlir, **E. E. Fullerton** and C. H. Back. "Accessing the Magnetic Susceptibility of FeRh on a Sub-nanosecond Time Scale," Ultrafast Magnetism I, pp. 294-296. Accepted Aug. 6, 2014. Springer International Publishing, 2015.

U. Bierbrauer, S. Alebrand, M. Hehn, M. Gottwald, D. Steil, D. Lacour, **E. E. Fullerton**, S. Mangin, M. Cinchetti and M. Aeschlimann. "All-Optical Switching in CoTb Alloys: Composition and Thickness Dependent Studies," Ultrafast Magnetism I, pp. 244-247. Accepted Aug. 6, 2014. Springer International Publishing, 2015.

Professor Sungho Jin

P-K. Nguyen, **S. Jin** and **A. E. Berkowitz**, "MnBi particles with high energy density made by spark erosion," Journal of Applied Physics 115, 17A756, March 2014.

C.J. Frandsen, K.S. Brammer, K. Noh, G. Johnston and **S. Jin**. "Tantalum coating on TiO< sub> 2</sub> nanotubes induces superior rate of matrix mineralization and osteofunctionality in human osteoblasts," Materials Science and Engineering: C 37 (2014): 332-341.

Y.-K. Hong, T. Haskew, O. Myryasov, **S. Jin** and **A. E. Berkowitz**. "Rare-Earth-Free Permanent Magnets for Electrical Vehicle Motors and Wind Turbine Generators: Hexagonal Symmetry Based Materials Systems Mn-Bi and M-type Hexaferrite," DOE-ALABAMA-0000189. June 2014.

Professor Vitaliy Lomakin

A. Singh, S. Gupta, M. Kuteifan, M. Lubarda, **V. Lomakin** and O. Mryasov, "Effect of interlayer exchange coupling parameter on switching time and critical current density in composite free layer," J. Applied Physics, 115, 17D111, 2014.

Y. Brick, **V. Lomakin** and A. Boag. "Fast Direct Solver for Essentially Convex Scatterers Using Multilevel Non-uniform Grids," IEEE Transactions on Antennas and Propagation, Vol. 62, No. 8, 4314-4324, August 2014

Professor Steve Swanson

J. Hu, Y. Yu, H. Han, F. Civoli, Y. Zhuang, J. Thomas, **S. Swanson**, S. Jing and S. Gupta, "Development of a Novel BAFF Responsive Cell Line Suitable for Detecting Bioactive BAFF and Neutralizing Antibodies against BAFF- Pathway Inhibiting Therapeutics," Cell, Vol. 3, pp. 79-91, February 10, 2014.

Professor Frank Talke

W. Song, L. Li, I. Etsion, A. Ovcharenko and **F.E. Talke**. "Yield inception of a soft coating on a flat substrate indented by a rigid sphere," Surface and Coatings Technology, Vol. 240, pp. 444-449, 2014.

D. Pan, A. Ovcharenko, M.Yang, F. Radicati and **F.E. Talke**. "Effect of pitch and roll static angle on lubricant transfer between disk and slider," Tribology Letters 53, No. 1, pp. 261-270, 2014.

C. Zhang, A. Ovcharenko, M. Yang, N. Knudson and **F.E. Talke**, "An investigation of thermal asperity sensors during contact with disk." Microsystem Technologies, Vol. 20, Issue 8-9, pp. 1529-1534, August 2014.

Y.W. Seo and **F.E. Talke**. "Modeling of Amorphous Carbon Overcoat for Investigation of Lubricant Transfer at the Head-Disk Interface," ASME 2014 Conference on Information Storage and Processing Systems, American Society of Mechanical Engineers, June 23-24, 2014.

Z. Tang and **F.E. Talke**. "Investigation of Slider Vibrations and Vibration Mode Changes in Helium-Air Gas Mixtures," ASME 2014 Conference on Information Storage and Processing Systems, American Society of Mechanical Engineers, June 23-24, 2014.

L. Li, K. Morris, J. Hogan and **F.E. Talke**. "Design of a Collocated Dual Stage Suspension in a Hard Disk Drive," ASME 2014 Conference on Information Storage and Processing Systems, American Society of Mechanical Engineers, June 23-24, 2014.

A. Hegetschweiler, L. Matthes and **F.E. Talke**. "Nano Wear of Thermal Flying Height Control Sliders," ASME 2014 Conference on Information Storage and Processing Systems, American Society of Mechanical Engineers, June 23-24, 2014.

Z. Tang and **F.E. Talke**. "An Experimental Study of the Fretting Wear Coefficient for the Dimple-Gimbal Interface," ASME 2014 Conference on Information Storage and Processing Systems, American Society of Mechanical Engineers, June 23-24, 2014.

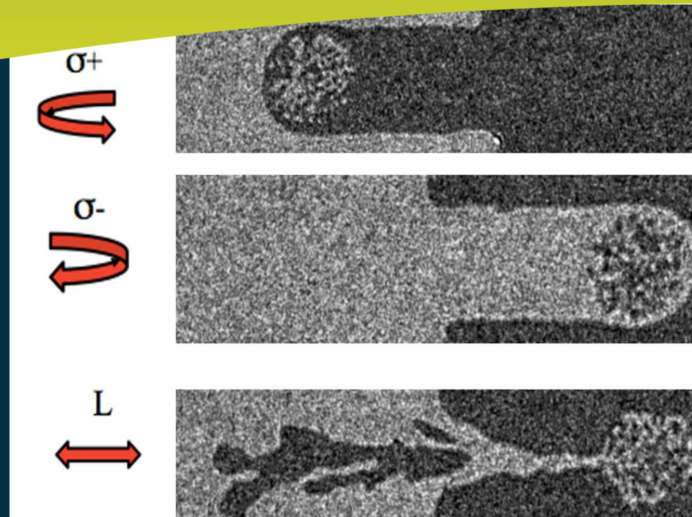
Assistant Professor Oleg Shpyrko

C. Rizal, B. Moa, J. Wingert and **O. Shpyrko**. "Magnetic Anisotropy and Magnetoresistance Properties of Co/Au Multilayers." In IEEE Explore, August 2014.

ISSUE 42 FALL 2014

CMRR REPORT

CENTER FOR MAGNETIC RECORDING RESEARCH
University of California, San Diego ISSN: 0888-7381



this issue

FACULTY PROFILE

PRABHAKAR BANDARU
Professor, MAE

Prabhakar Bandaru is a professor in UC San Diego's Mechanical and Aerospace Engineering Department. He is also an affiliate of the Electrical and Computer Engineering and the Nanoengineering departments. After receiving his Ph.D. from UC Berkeley, he worked at Applied Materials, Inc. on non-volatile random access memories. He was then a postdoctoral fellow in the Electrical Engineering and Physics departments at UCLA on low-temperature physics as related to quantum information processing. Dr. Bandaru then joined UC San Diego as an assistant professor.

Bandaru and his research group are mainly interested in analytical and experimental materials physics and chemistry, broadly looking at the electrical, thermal, electrochemical, magnetic, photonic and mechanical properties of materials at the mesoscopic and microscopic levels.

Professor Bandaru has received various awards, including the Vice Chancellor's award for graduate dissertation research, Flint Seminar series lectureship in Applied Physics at Yale University, a "Career" grant from the NSF and the Scientific American Top 50 Award.

continues on page 7

Hard Drives: Faster, Simpler and Higher Density

Researchers in the Center for Magnetic Recording Research (CMRR) at the Jacobs School of Engineering have discovered that for a wide range of ferromagnetic materials the direction of magnetization can be completely controlled by polarized light without the need for magnetic fields, a finding that could significantly affect the data memory and storage industries that produce hard disks and magnetic random access memories. Their research, published Aug. 21 in the journal *Science Express*, focused on materials currently being developed for high-density storage applications.

Ferromagnetism's most familiar form is the humble refrigerator magnet, but it is also a core component in many electrical devices, including magnetic storage used in commercial computing applications. In traditional magnetic storage devices magnetic bits are switched using magnetic fields, a slow process that consumes considerable energy and is reaching its density limits.

"Our results showing that it is possible to switch magnetic bits using only the polarization of light could significantly simplify the design and improve the speed of magnetic recording," said CMRR director and electrical and computer engineering professor Eric Fullerton. "Magnetic storage is emerging in the memory market due to demands for higher-density, fast, and low power non-volatile memory. As industry trends toward silicon nanophotonics, miniaturization, and photonic-electronic integration the ability to couple photonic, electronic, and magnetic materials could enable completely new applications."

Fullerton is also a professor of nanoengineering at UC San Diego Jacobs School of Engineering.

Led by Fullerton, the international and interdisciplinary research team tested a rapid-pulse laser at a variety of ferromagnetic materials including magnetic thin films, multilayers and granular films. Previously, scientists have only been able to use all-optical control on a small set of ferrimagnetic materials that did not lend themselves for data storage applications.

The next step is to scale the technology to be able to write data on the nanoscale (vs. the microscale as the team demonstrated) and time scales required for magnetic recording.

"There is also a lot of work to understand the underlying mechanisms for optical switching of ferromagnets," said Fullerton. "We showed it works. Why it works and how to optimize it for applications still need to be addressed."

The research team includes first author Charles-Henri Lambert a Ph.D. student at the University of Lorraine in France who participated in the research as a visiting student at UC San Diego and second author Stephane Magin, also of the University of Lorraine, who was on sabbatical at UC San Diego at the time.

The paper is "All-optical control of ferromagnetic thin films and nanostructures." In addition to Magin and Lambert, the international research partners included scientists from the National Institute for Materials Science in Japan and the University of Kaiserslautern in Germany. The research was funded in part by an Office of Naval Research Multidisciplinary University Research Award.

Image above: Magnetic domains in cobalt platinum alloy multi-layer film exposed to laser light where dark gray indicates opposite orientation.

Ph.D. Graduates

MINGHAI QIN
Department: ECE
Ph.D.: September 2014
Advisor: Paul H. Siegel
Thesis: Signal Processing and Coding for Non-Volatile Memories
Job: Storage Architecture Engineer
Now at: HGST Research

AMAN BHATIA
Department: ECE
Ph.D.: August 2014
Advisor: Paul H. Siegel
Thesis: Improved Coding Techniques for Digital Recording Systems
Job: NAND Management
Now at: SK Hynix Memory Solutions

RUINAN CHANG
Department: ECE
Ph.D.: September 2014
Advisor: Vitaliy Lomakin
Thesis: Finite Element and Integral Equation Methods for High-Performance Micromagnetic and Electromagnetic Solvers
Now at: Oracle

Letter from the Director

Eric Fullerton
Director, CMRR

This newsletter comes at a time with many new activities as well as new and returning faces to CMRR. The center was renewed as an organized research unit (ORU) after a one-year review by the UCSD Office of Research Affairs. The conclusions were very positive and commented on the breadth of research and strong funding from our corporate members as well as state and federal sponsors. In the review process, it was recommended that a name change may be needed to reflect the current research portfolio. To address this issue, we are considering a name change to Center for Memory and Recording Research to maintain the CMRR acronym but reflect the research in non-volatile memory.

We welcome our visiting scholars: Dr. Yukiko Takahashi from the National Institute for Materials Science in Tsukuba, Japan; Dr. Yuan Zhu from Sun Yat-sen University in China; Dr. Jun Huyn Han from Chungnam National University, and Dr. Jin-Kyu Byun from Soongsil University, in Daejon and Seoul, Korea, respectively. We also welcome three new visiting graduate students; six Ph.D. students, three new post-doctoral researchers and several undergraduates who are volunteers. Welcome to all of you.

Over the summer, we had eight CMRR graduate students participating in summer internships with a range of employers, including Western Digital, Intel, HGST, Northrop Grumman, Sandia National Lab, and SPAWAR. Their summer projects covered much of the current research at CMRR. This strong interaction of our students with our industry partners is a cornerstone of the CMRR mission, i.e., to train students for the information technology industries. I hope we continue to keep this strong participation of our students with our corporate sponsors in the coming years.

We continue to expand our educational and outreach efforts by organizing various conferences and workshops. In particular, I would like to highlight the upcoming 6th annual Non-Volatile Memories Workshop (NVMW 2015), part of a conference series that provides a unique showcase for outstanding research on solid-state, non-volatile memories. It will feature a vertically-integrated program that includes presentations on devices, data encoding, systems architecture, and applications related to these exciting new data storage technologies. NVMW 2014 included 32 speakers from top universities, industry research labs, and device manufacturers, and the workshop attracted over 230 attendees. For more information, visit http://nvmw.ucsd.edu/. We plan to host more such workshops going forward and as part of future research reviews. We would appreciate input on potential topics.

Finally I would like to highlight that we are changing the name of the CMRR auditorium to the Jack Keil Wolf Auditorium at CMRR in honor of the late Jack Wolf, one of the founding CMRR faculty. This will be in recognition for Jack's extensive contributions to research and education at CMRR, UC San Diego, and the broader engineering community. The naming ceremony will be Oct. 28 at 2-4pm in the Jack Keil Wolf Auditorium. The event will include a technical presentation by Prof. Shivendra S. Panwar on the topic, "Streamloading: Low-Cost, High-Quality Video Streaming," (see page 4), as well as brief testimonials by some of Jack's former students and remarks from campus administrators. I hope you may be able to join us.

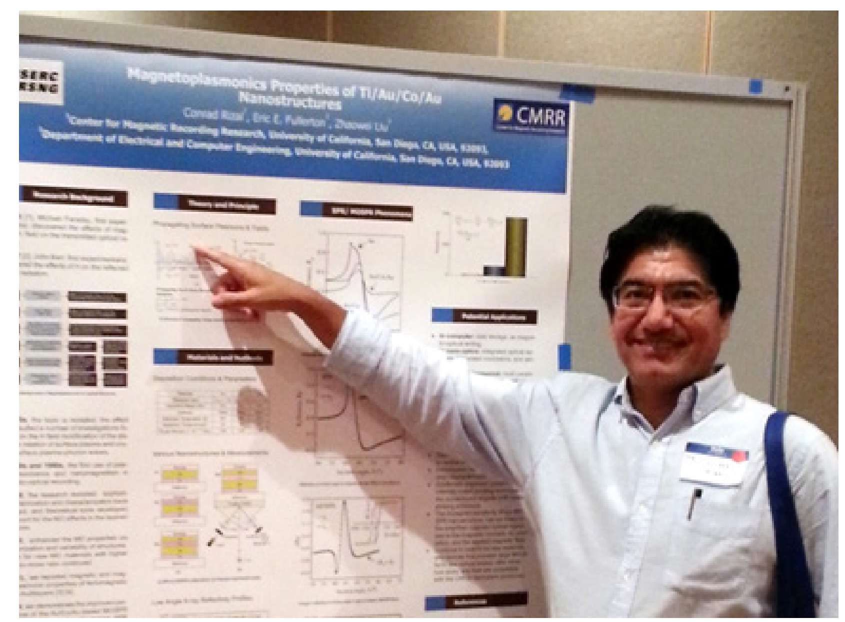
FACULTY PROFILE *continued from page 1*

The authors of this article are Massimiliano Di Ventra from the Department of Physics at UC San Diego, Fabio Traversa from the Department of Physics at UCSD and the Department of Electronics and Telecommunication at the Politecnico di Torino in Turin, Italy, and Yuriy V. Pershin from the Department of Physics and Astronomy at the University of South Carolina in Columbia, SC.

The corresponding author of this article is Massimiliano Di Ventra. He can be contacted at diventra@physics.ucsd.edu.

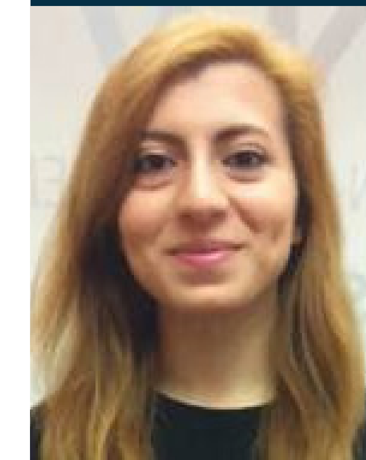
This work is a collaborative effort between CMRR and the Physics Departments at UC San Diego and the University of South Carolina. It is partially supported by NSF grant ECCS-1202383.

Prab Bandaru's previous research accomplishments range from synthesis of a new material, (Mn,Cr)Bi, with a high magneto-optic figure of merit: the discovery from first principles of the beneficial effect of alpha-hydroxy acids for defect-free semiconductor surfaces, establishing the maximum Seebeck coefficient for thermoelectrics in any dimensionality, measurement of the electrical conduction activation energies in single molecular magnets, use of helical and Y-shaped carbon nanostructures for inductors and nanoelectronics, seminal optical measurements of thin film thermal conductivity, texture-induced surface plasmons, silicon-germanium photonics integration and more.. Recently, Bandaru has focused his efforts on establishing the fundamental limitations for electrochemical energy storage through quantum capacitance-based ideas. He has also been working on non-resonant thermal metamaterials involving the manipulation of thermal heat flux where aspects related to flux bending, anomalous refraction and tensorial thermopower were discovered. Bandaru's group is also studying nanoscale conductive and radiative heat transfer, with possible application to thermally assisted magnetic recording.



Conrad Rizal is a post-doctoral researcher in Professor Eric Fullerton's group.

He was selected to present "Magnetoplasmonics Properties of Au/Co/Au Nanostructures" during a poster presentation at the Postdoctoral Research Symposium 2014.



Agapi (Gabby) Tshamjyan is the administrative assistant at CMRR, and has returned to work after her summer break.

She is a second-year undergraduate student here at UC San Diego's Revelle College. Currently, she is majoring in Human Biology, and plans to double major in Public Health.

Tshamjyan is involved in various organizations within UC San Diego, and is excited to assist all of CMRR.

[10] W. Maass, T. Natschlager, and H. Markram, *Real-time computing without stable states: A new framework for neural computation based on perturbations*, Neural Comput., 14, 2531–2560, 2002.
[11] Guest editor A. Adamatzky, *Special Issue: Unconventional Computing*, International Journal of General Systems, 43,7, 2014
[12] M. A. Nielsen and I. L. Chuang, *Quantum Computation and Quantum Information*. Cambridge Series on information and the Natural Sciences, Cambridge University Press, 10th Anniversary edition, 2010.
[13] E. R. Kandel, J. H. Schwartz, T. M. Jessell, *Principles of neural science*, McGraw-Hill, 2000.
[14] M. Di Ventra, Y. Pershin, and L. Chua, *Circuit elements with memory: Memristors, memcapacitors, and meminductors*, Proceedings of the IEEE, 97, 1717–1724, 2009.
[15] J. Martinez-Rincon, M. Di Ventra, and Yu. V. Pershin, *Solid-state memcapacitive system with negative and diverging capacitance*, Phys. Rev. B, 81, 195430, 2010.

continued from page 3

Figure 3a shows the calculated Purcell factors for isotropic dipoles at a distance of d =10 nm above the Ag film and the Ag-Si multilayer HMM, respectively, at various emission wavelengths. The Purcell factor for a bulk Ag layer peaks at λ = 360 nm with a narrow bandwidth of ~10 nm, corresponding to surface plasmon resonance of the Ag film. In contrast, for the Ag-Si multilayer HMM the Purcell factor peaks around λ = 600 nm with a much broader bandwidth of over 60 nm, which aligns better with the emission spectrum of Rhodamine 6G (R6G). The Purcell enhancement at 600 nm is ~60-fold on the Ag-Si multilayer HMMs but less than ten-fold on the Ag film. of an external power source. These systems are resistors, capacitors and inductors with memory (memristors, memcapacitors, and meminductors, respectively) [14]. They can also be made using CMOS-compatible structures and devices, thus offering unprecedented opportunities in electronics. In particular, these standard and non-standard systems and devices allow precisely the paradigm we are looking for. We named this paradigm memcomputing i.e., computing within memory [4], [5], namely, the ability to process information directly in/by the memory (see Figure 1, right panel for a schematic of a memcomputing architecture). This computing paradigm rests on the solid mathematical foundation of universal memcomputing machines [5]. We have indeed recently shown that these machines have the same computational power of non-deterministic Turing machines, thus allowing the solution of complex problems in polynomial time with polynomial resources.

Practical realizations

We have recently proposed a simple and practical realization of memcomputing [6] that utilizes easy–to-build memcapacitive systems [15]. We have named this architecture dynamic computing random access memory (DCRAM) (see Fig. 2). We have shown that DCRAM provides massively-parallel and polymorphic digital logic; namely, it allows for different logic operations within the same architecture by varying only the control signals. In addition, by taking into account realistic parameters, its energy expenditures can be as low as a few fJ per operation. DCRAM is also fully compatible with CMOS technology, can be realized with current fabrication facilities and therefore can serve as an alternative to the present computing technology.

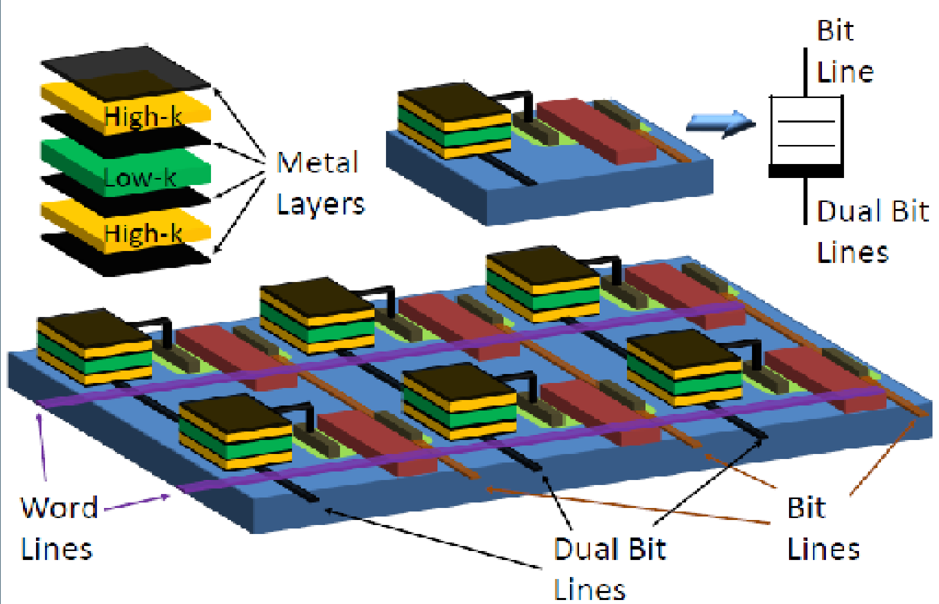


Fig. 2: Scheme of a DCRAM architecture

Conclusions

In conclusion, we have introduced the concept of computing with and in memory: memcomputing. This new computing paradigm can be realized in the solid state with available systems and materials and it is compatible with CMOS technology. It provides a solution to the time and energy constraints of traditional von Neumann architectures, while offering a powerful new computational tool for solving complex problems that currently require an exponentially large number of resources and time.

References

[1] J. von Neumann, *First draft of a report on the edvac*, Annals of the History of Computing, IEEE, 15, 4, 27–75, 1993.
[2] A. M. Turing, *On computational numbers, with an application to the entscheidungsproblem*, Proc. of the London Math. Soc., 42, 230–265, 1936.
[3] A. M. Turing, *The Essential Turing: Seminal Writings in Computing, Logic, Philosophy, Artificial Intelligence, and Artificial Life, Plus The Secrets of Enigma*. Oxford University Press, 2004.
[4] Di Ventra, M., Pershin, Y. V., *The parallel approach*, Nature Physics, 9, 200, 2013.
[5] Traversa, F., Di Ventra, M. *Universal Memcomputing Machine*, arXiv:1405.0931, 2014.
[6] Traversa, F. L. Bonani, F. Pershin, Y. V. Di Ventra, M., *Dynamic Computing Random Access Memory*, Nanotechnology, 25, 285201, 2014.
[7] Pershin, Y. V. Di Ventra, M. *Experimental demonstration of associative memory with memristive neural networks*, Neural Networks, 23, 881, 2010.
[8] Borghetti, J., Snider, G. S., Kuekes, P. J., Yang, J. J., Stewart, D. R., Williams, R. S., *Memristive switches enable `stateful' logic operations via material implication*, Nature, 464, 873–876, 2010.
[9] Pershin, Y. V., Di Ventra, M., *Solving mazes with memristors: a massively-parallel approach*, Phys. Rev. E, 84, 046703, 2011.

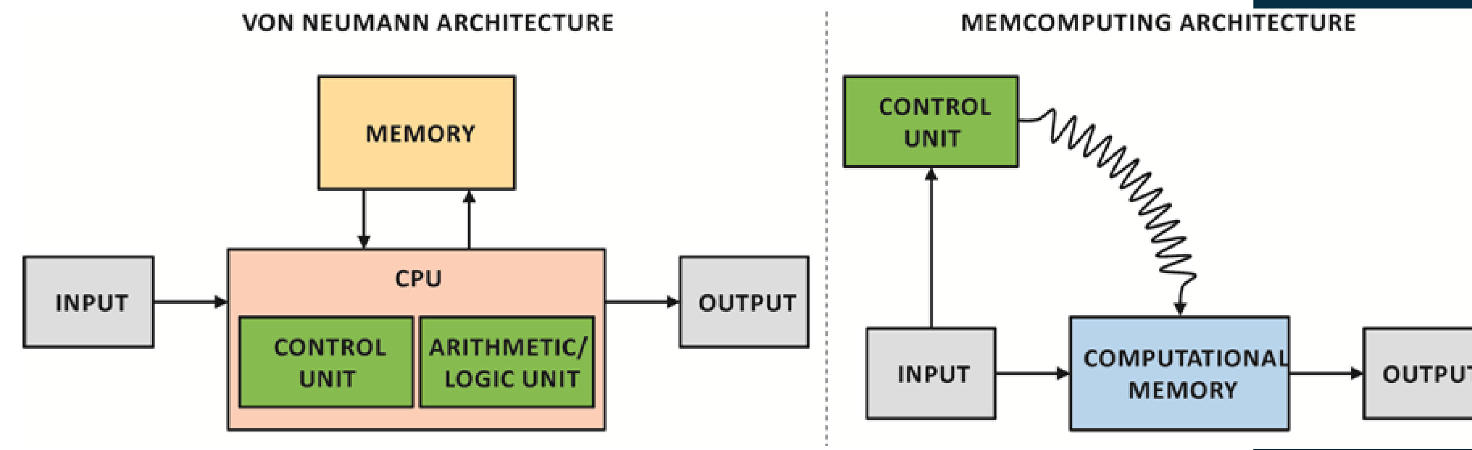


Fig. 1: Von Neumann architecture versus the Memcomputing architecture

RESEARCH HIGHLIGHT

Memcomputing:Computing *With* and *In* Memory

By:
Massimiliano di Ventra,
Fabio Traversa,
Yuriy V. Pershin

The Need for a New Computing Paradigm

Current electronic systems used for computing (PCs, workstations and clusters) are based on the von Neumann architecture (see Figure 1, left panel) [1]. This computing paradigm employs the Turing machine concept [2], [3], and involves a significant amount of information transfer between a central processing unit (CPU) and memory, with concomitant limitations in the actual execution speed and large amounts of energy used to move data. Therefore, there is currently a surge of interest in unconventional computing approaches [4]-[11] that can outperform the present von Neumann approach [4], [5]. It is clear that such alternatives have to fundamentally depart from the existing one in both their computational complexity as well as in the way they handle information. For at least a couple of decades, quantum computing [12] has been considered a promising alternative in view of its intrinsic massive parallelism afforded by the superposition principle of quantum mechanics. However, the practical realization of quantum computers seems still too far away from the present and even near-future, technologies.

In order to overcome the above mentioned limitations, we need to look for another paradigm. The solid-state emulation of our own brain may provide the solution.

It is estimated that our brain uses only 10 to 25 Watts per day to perform about 10^{16} operations per second [13]. A supercomputer would require more than 10^{7} times that power to do the same amount of operations. And a computer does not even come close to performing such complicated tasks as pattern recognition, optimization problems, decision making, etc. we do in the noisy and unpredictable environment we live in, and in a massively-parallel way.

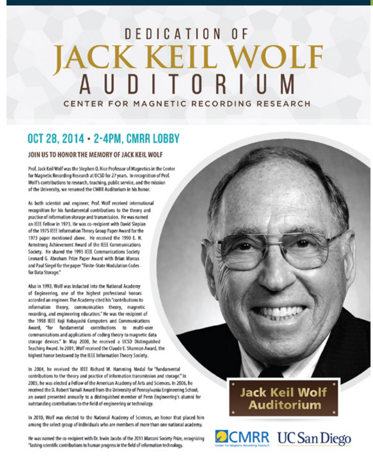
How is it then possible that our brain is such a powerful computing machine and yet uses so little energy to operate? The answer definitely cannot come only from the number of computing elements (about 10^{11} neurons). Rather, it has to ultimately boil down to the fundamentally different way in which computation and information storage are accomplished in our nervous system. In fact, unlike our present (super) computers, calculations in the brain are not performed in a CPU that is physically separated from the memory: our brain computes and stores information on the same physical location. This way of computing avoids the large amount of information transfer to/from the CPU and the memory, saving both energy and time.

Memcomputing

Can we realize this paradigm in the solid state? The answer is yes, with the available CMOS technology, as well as materials or two-terminal systems that can hold information even in the absence of an external power source. These systems are resistors, capacitors and inductors with memory (memristors, memcapacitors, and meminductors, respectively) [14]. They can also be made using CMOS-compatible structures and devices, thus offering unprecedented opportunities in electronics. In particular, these standard and non-standard systems and devices allow precisely the paradigm we are looking for. We named this paradigm memcomputing i.e., computing within memory [4], [5], namely, the ability to process information directly in/by the memory (see Figure 1, right panel for a schematic of a memcomputing architecture). This computing paradigm rests on the solid mathematical foundation of universal memcomputing machines [5]. We have indeed recently shown that these machines have the same computational power of non-deterministic Turing machines, thus allowing the solution of complex problems in polynomial time with polynomial resources.

continued on page 6

"Can we realize this paradigm in the solid state? The answer is yes."



Dedication of the Jack Keil Wolf Auditorium at CMRR

On October 28, 2014, 2-4pm, the CMRR community was slated to honor the memory of Professor Jack Keil Wolf, who was the Stephen O. Rice Professor of Magnetics in CMRR at UC San Diego for 27 years. In recognition of Prof. Wolf's contributions to research, teaching, public service and the mission of the university, CMRR renamed its auditorium in Wolf's honor.

As both a scientist and an engineer, Prof. Wolf received international recognition for his fundamental contributions to the theory and practice of information storage and transmission. He was named an IEEE Fellow in 1973, and was co-recipient with David Slepian of the 1975 IEEE Information Theory Group Paper Award. Wolf was inducted into the National Academy of Engineering in 1993, and received the IEEE Koji Kobayashi Computers and Communications Award in 1998. In 2001 he received the Claude E. Shannon Award from the IEEE Information Theory Society, and three years later Wolf accepted the IEEE Richard W. Hamming Medal for fundamental contributions to the theory and practice of information transmission and storage. In 2010 he was elected to the National Academy of Sciences.

NEW CMRR RESEARCHERS

James Anagnost is a fourth-year undergraduate student studying Electrical Engineering at the UC San Diego. He is currently working in the lab of Dr. Fred Spada for Safe Erasure of Magnetic Media. In future, Anagnost plans to pursue graduate studies in Signal Processing, Materials Science, or Photonics.

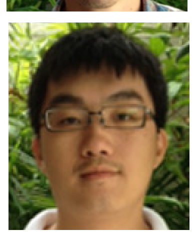
Sarit Buzaglo is a post-doctoral employee at CMRR under the supervision of Prof. Paul H. Siegel. She has recently received her Ph.D. from the Department of Computer Science at Technion-Israel Institute of Technology, where she has worked under the supervision of Prof. Tuvi Etzion and Prof. Eitan Yaakobi. Dr. Buzaglo's research interests include error-correction coding for storage devices and fault-tolerant coding for distributed storage networks.

Jin-Kyu Byun is an associate professor at Soongsil University in Seoul, Korea. He received his Ph.D. from Seoul National University in 2001, and worked as a postdoctoral researcher at the University of Illinois at Urbana-Champaign from 2003-2005. Prof. Byun's research interests include optimization of electromagnetic devices, simulation of magnetic field-induced current in the human body and simulation of wireless power-transfer systems. Dr. Byun joined Prof. Vitaliy Lomakin's research group as a visiting scholar in January 2014. His current research focus involves the optimal design of spin torque oscillators (STOs) using FastMag, a micromagnetic simulator.

Matthew Ellis is a Ph.D. student from the University of York in the UK, where he is studying under the supervision of Prof. Roy Chantrell. For his Ph.D., Ellis has worked on computational models of magnetization dynamics and magnetic recording media at an atomistic scale. In particular, he has investigated the properties of FePt for heat-assisted magnetic recording. He is joining CMRR to work with Prof. Fullerton in modeling all-optical switching in FePt.

Jun Huyn Han is currently a visiting scholar in Prof. Sungho Jin's research group. Since 2011, he has been an associate professor in the Department of Nano Materials Engineering at Chungnam National University in Daejeon, South Korea. Han obtained his Ph.D in 2004 in Materials Science and Engineering from Seoul National University.. Prof. Han's current research interests at UC San Diego include fatigue lifetime improvement of the magnetic shape memory alloy thin films, which can be applicable to micro-actuators and texture control of magnetic thin films.

Tyler Hennen is an incoming graduate student joining the group of Prof. Eric Fullerton. He previously worked at HGST San Jose Research Center doing magnetic characterization of advanced recording media. Hennen received a dual Bachelor's degree in Physics and Mathematics from the University of Minnesota.



Chih-Cheng Huang is a second-year Ph.D. student in the Materials Science and Engineering Program at UC San Diego. He received his B.S. degree in Materials Science and Engineering from National Taiwan University in 2010 and M.S. degree in Nanoengineering from National Tsing Hua University in 2012. He is currently working with Prof. Drew Hall to develop a novel, magnetoresistive biosensing platform based on magnetorelaxometry (in collaboration with Prof. Eric Fullerton).

Pengfei Huang is a new graduate student in Prof. Paul Siegel's group. He earned his M.S. degree in Information and Communication Engineering in 2013 from Shanghai Jiao Tong University, after which he enrolled in UC San Diego to do his doctorate in Communication Theory and Systems (which he hopes to complete in 2017). Huang received his B.S. degree from Zhejiang University in Information and Communication Engineering in 2010.

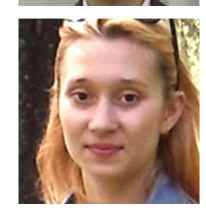
Gunwoo Kim is a second-year Ph.D. student in Materials Science and Engineering at the UC San Diego. He obtained his M.S. from the Department of Science at the University of Tokyo. He is working under the supervision of Prof. Sungho Jin, and his research interest is in superparamagnetic nanoparticles and their applications.

Roopali Kukreja is a postdoctoral researcher at CMRR who will be working under the supervision of Prof. Eric Fullerton, effective Oct. 15, 2014. She obtained her Ph.D. from Stanford University in Materials Science and Engineering. During her Ph.D., Dr. Kukreja worked on imaging of ultrafast phase separation in magnetite and spin injection into copper across a Co/Cu interface. She will be working under supervision of Prof. Fullerton and Physics Prof. Oleg Shpyrko. Her research interests involve investigating magnetic materials and magnetization dynamics using time resolved x-ray techniques.

Sheena Patel is an incoming first-year graduate student in the Physics Department at UC San Diego. She received her B.S. in Physics from Harvey Mudd College in 2014, where she studied magnetotransport properties of ferromagnetic Co/Ni multilayers and ferrimagnetic Co/Tb multilayers. She joined Prof. Fullerton's group in August 2014.

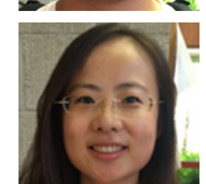
Conrad Rizal has been a Postdoctoral Scholar-Employee at CMRR since June 9, 2014. He is working under the supervision of Professors Eric Fullerton and Zhaowei Liu, and his scientific activities include optimizing magnetic, microstructure, and magneto-optical properties of ferromagnetic multilayers, as well as developing novel magnetoplasmonic materials and devices. Dr. Rizal obtained his Ph.D. in electrical and computer engineering at the University of British Columbia, Canada, and M.Sc. in electronics at the Muroran Institute of Technology in Japan.

Yukiko Takahashi is a visiting scholar from the National Institute for Materials Science in Japan, where she works on the magnetic materials for HDD and spintronic devices. Takahashi is working in the lab of Prof. Eric Fullerton, where she will investigate all-optical magnetic switching.



Iana Volvach is an incoming Ph.D. student in the Materials Science and Engineering program at UC San Diego. She obtained her M.S. degree in the department of Radio Physics at Kharkiv National University in Ukraine. Volvach is working under the supervision of Prof. Vitaliy Lomakin, and her research interest involves physics of nanomagnetic materials and micromagnetic modeling and simulation.

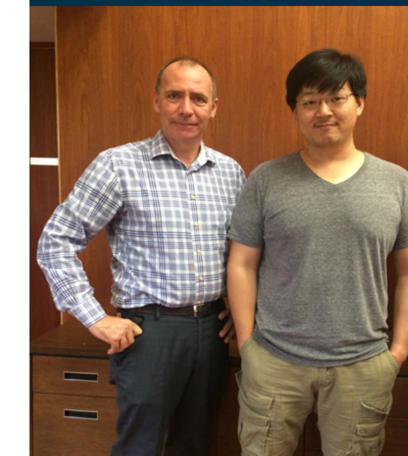
Sicong Yan is a visiting graduate student at CMRR working under the supervision of Prof. Lomakin. He received his B.S. degree in July 2013 and is currently a second-year graduate student from Tongji University in Shanghai, where he is working on a Master's degree in electromagnetic and microwave technology. At CMRR, he is working in the lab of Prof. Lomakin on computational electromagnetics.



Sarah (Ying) Zhong is a third-year Ph.D. student from State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin, China. She came to UC San Diego in September 2013 as a visiting student for a two-year program supervised by Prof. Sungho Jin. Her main research interest is materials and their application and reliability in electronic packaging. Zhong is working on nano-solders for electronic devices.

Yuan Zhu is a visiting scholar in Prof. Zhaowei Liu's group. Dr. Zhu received her BE and Ph.D. degrees in Material Science from Tsinghua University in China. Her research interests center on heat transfer materials/measurements, semiconductor materials and optoelectronics. At CMRR, Dr. Zhu is working on heat transport measurement in metamaterials.

Fellow. Mentor. Advisor.



Richard Choi (at right) and Professor Eric Fullerton's "Tunable Low-Power RF Oscillators Based on Magnetic Thin Film Devices for Cost-Effective and Energy Efficient RF Telecommunication Systems" has been chosen as one of the four winners of Qualcomm Fellow-Mentor-Advisor (FMA) Fellowships. The Qualcomm FMA Fellowship is a 12-month fellowship program for outstanding UC San Diego Jacobs School of Engineering doctoral students nominated by their faculty advisors. The program brings together teams which include an engineering Ph.D. candidate, his or her faculty advisor and an engineering mentor from Qualcomm. The goal is to foster in-depth connections between the Jacobs School faculty and Qualcomm engineers while enhancing the education of doctoral students. Choi's Qualcomm mentor will be Ken Lee. The $75,000 collaboration will be funded out of the $300,000 Qualcomm FMA Program.