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CMRR Report

Center for Magnetic Recording Research

Number 26 Summer 2006

Research Highlight

Simulation and Testing Of the Head Disk Interface for Discrete Track Media

New CMRR Endowed Chair Professor

CMRR is celebrating the appointment of Dr. **Eric Fullerton** to the position of Professor of Electrical Engineering (ECE) and holder of a CMRR Endowed Chair, effective November 1 of this year.

Eric's expertise is in the synthesis and characterization of magnetic nanostructures for use as probes to understand the nature of magnetic materials at very small scales, as well as in the development of novel magnetic recording technologies. He comes to UCSD with over 15 years of research experience, including positions at Argonne National Laboratory, the IBM Almaden Research Center and, most recently, the San Jose Research Center of Hitachi Global Storage Technologies (GST), where he is a Research Staff Member and Manager of the Fundamentals of Nano-structured Materials Group.

Eric has co-authored more than 160 papers and holds 18 patents. His patent on "Magnetic recording media with antiferromagnetically coupled (AFC) ferromagnetic films as the recording layer" was selected by MIT's Technology Review magazine as one of the "Five Patents to Watch" in 2001. That patent, along with two subsequent patents, have been recognized by IBM and Hitachi GST as among their most valuable. The invention of AFC media allowed the data storage industry to achieve unprecedented increases in areal density, overcoming what had been thought to be an insurmountable hurdle, known as the "superparamagnetic effect," by sandwiching a mere three-atom-thick layer of ruthenium – dubbed "pixie dust" – between two magnetic layers.

Eric, who was named a Fellow of the American Physical Society in 1998, is internationally acclaimed not only for his technological innovations, but also for his fundamental contributions to the physics of magnetic thin films and superlattices, and for novel applications of x-ray and neutron scattering to the study of magnetic materials.

The timing of Eric's appointment is indeed fortuitous. He will be a major contributor to CMRR's recently initiated Patterned Media Project, as well as in the ongoing materials science and engineering programs at UCSD. He can also be expected to play a key role in the effort to establish a new department devoted to nanoscience engineering in the Jacobs School of Engineering.

We are all delighted to welcome Eric to the CMRR family.

From the Director

Unless you are a newsletter reader who turns first to my column, you are already aware of the "front page" news: Dr. **Eric Fullerton** will be joining the CMRR faculty as a Professor of Electrical and Computer Engineering and holder of a CMRR Endowed Chair. It is difficult to overstate the importance of this appointment. Eric will strengthen, broaden, and accelerate the Center's research efforts in the area of materials for recording media and read/write transducers. In particular, we eagerly anticipate his contributions to the flourishing CMRR Patterned Media Project. Welcome, Eric!

It is also a pleasure to welcome Dr. **Akihiro Inomata**, a Visiting Scholar from Fujitsu Labs, who, during the coming year, will collaborate with Prof. Sungho Jin on studies related to patterned-media fabrication.

To emphasize the scope of the patterned media effort, this issue features a Research Highlight from Prof. Talke's group describing head-disk interface issues for discrete-track and bit-patterned media. Significant progress is being made in other aspects of the patterned media project, as well, including nanomagnetic modeling, quasi-static read/write measurements, servo pattern simulation, and channel design. Details will be presented at the upcoming Fall Research Review.

I invite you to enjoy the rest of the newsletter and encourage you to stay in touch with all of the trail-blazing research going on at the Center.

In Remembrance - Eric David Boerner January 1968 – September 2006

With great sadness we report the passing of our friend and colleague **Eric Boerner**. Eric was a physics department major at UCSD and a graduate student at CMRR from 1996 to 2000. After receiving his Ph.D. in 2000, he was employed as a research scientist at the Seagate Corporation in Pittsburgh, Pennsylvania.

It is painful to find myself writing this note because I was extremely fond of Eric. It was the greatest pleasure to have him in my graduate program. He was an ideal student and collaborator: always cheerful and filled with enthusiasm for his projects. Eric was extremely bright, he worked with great diligence and he interacted happily with all his colleagues: the students, the staff at CMRR and his professors.

Eric's thesis was focused on one of the key problems in magnetic storage: the role of thermal fluctuations in ferromagnetic materials. Thermal fluctuations set the minimum size limit to magnetic grains and thus the limit to achievable recording densities. Eric's thesis contains a superb review of the various means of calculating or simulating thermal effects. He also studied thermal effects in patterned media, a subject that today, more than seven years after his work was published, is being studied intensely as the most likely medium to increase storage densities to 2-3Tbit/in^2. Eric also focused on basic mechanisms of dynamic relaxation, which occur via magnetoelastic interactions to thermal fluctuations in the atomic lattice. I strongly recommend all researchers in the areas of both high areal density and high data rate to read Eric's thesis. His work was important then and is even more relevant today.

In my own current research I have thought often of phoning Eric for discussions. He was a valuable member of the physics and information storage communities. Eric was also an exceptionally kind and generous-hearted young man. We will all miss him very much.

Professor Emeritus H. Neal Bertram

CMRR Student Awards

Bart Raeymaekers, a graduate student in Professor Frank Talke's lab has been awarded the **Barbara J. and Paul D. Saltman Distinguished Teaching Award for 2006.** As a graduate student teaching assistant in the Department of Mechanical and Aerospace Engineering, Bart has made a difference with his interaction, his creative thinking, and his ability to communicate effectively with undergraduate students. He has also updated and maintained the class website. His open door office hours and his willingness to welcome new ideas and approaches have contributed to his excellent teaching approach.

Professor Frank Talke, Bart Raeymaekers, Professor Paul Linden, Chair MAE Dept.

Maik Duwensee, a graduate student in Professor Frank Talke's lab has received the **Best University-Industry Paper Award** for his paper entitled "Simulation of the Head Disk Interface for Discrete Track media," from the Information Storage and Processing Systems (ISPS), a division of the ASME. Maik received the award in June at the 2006 ISPS conference at Santa Clara University. Congratulations Maik!

On May 4, 2006 the **Schultz Prize** was awarded to co-recipients **Sharon Aviran** and **Ismail Demirkan**. The prize is presented in recognition of CMRR graduate students who have distinguished themselves through the creativity of their research and the impact of their publications.

Ismail Demirkan, Professor Jack Wolf, Sharon Aviran

Prior to coming to UCSD, Sharon received a B.A. degree in Statistics and Economics from the Hebrew University, Jerusalem, Israel and a M.Sc. degree in Operations Research from the Technion, Haifa, Israel. Her Ph.D. dissertation was entitled "Constrained Coding and Signal Processing for Storage Systems". Sharon's area of research includes the design and analysis of efficient constrained codes, and the joint detection and decoding of coded signals in the presence of colored noise. Sharon received her Ph.D. in July 2006 and is currently a Postdoctoral Researcher with Prof. Paul Siegel and Prof. Jack Wolf.

Ismail also received his Ph.D. in June 2006. He received his undergraduate degree in Electrical and Electronics Engineering from Bilkent University in Ankara, Turkey and his M.S. degree from UCSD. His area of research included modeling and detection of 2-dimensional holographic data storage channels and efficient methods for encoding 2-dimensional modulation codes. He spent a summer at Hitachi Global Systems where his research was concerned with designing block codes that satisfied both a running digital sum (RDS) and a time varying maximum transition run (TMTR) constraint for perpendicular storage channels. His Ph.D. dissertation was entitled "Coding and Detection for 2-Dimensional Channels". He is currently employed at Broadcom Corporation in Colorado.

The research of these two students at CMRR resulted in five publications in international journals and seven publications at international conferences.

Research Highlight

Simulation and Testing of the Head Disk Interface for Discrete Track Media

Maik Duwensee, D.E. Lee, Frank E. Talke

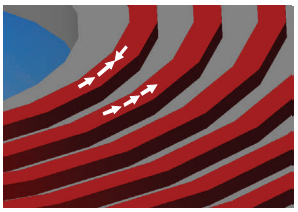
Introduction

Magnetic recording has become the main technology for the storage of digital data. It is believed [1] that perpendicular recording allows an increase in storage density to approximately 500Gbit/in^2 before the so-called super-paramagnetic limit will be reached. To increase the storage density beyond 500Gbit/in^2, patterned media recording [2] is being considered. In bit patterned media (BPM) recording, magnetic bits are recorded on individual "island-like" regions. In discrete track recording, (DTR), the magnetic information is stored on discrete tracks that are physically separated from each other. In BPM, magnetic transition noise is eliminated completely, while in DTR the transition noise is confined to noise in the circumferential direction [3]. However, the air bearing domain in patterned media is highly influenced by the existence of surface structures on the disk and the head. "Island-like" structures or circumferential grooves in the disk surface change the air bearing pressure distribution of the head/disk interface compared to non-structured head/disk interfaces. A number of researchers have investigated the effect of local spacing variations of the air bearing as a result of roughness [6] or surface texture on the head [7, 8] and disk [9].

The effect of discrete track disks on the flying characteristics of sub-ambient pressure sliders was investigated as a function of discrete track media parameters. A finite-element-based air bearing simulator [10] (CMRR simulator) was used to account for the characteristics of the grooved disk surface. The steady state flying behavior of typical proximity recording sliders over discrete track disks was studied and the influence of discrete track media parameters such as groove depth, groove width, and groove pitch was investigated with respect to the flying behavior of five types of sub-ambient pressure slider. Groove depths from zero to 40nm and groove widths from 500nm to 1000nm were evaluated. Flyability testing of sliders on patterned media was also conducted, with a significant variation in flyability observed as a function of groove depth.

Mathematical Modeling

Figure 1a) shows a schematic of a typical discrete track disk. Individual bits are stored along the circumferential ridges on the disk surface (white arrows in Figure 1a). In Figure 1b) the parameters defining discrete track media are shown. We note that *w* denotes the groove width, *p* the groove pitch, and *d* the groove depth, respectively.



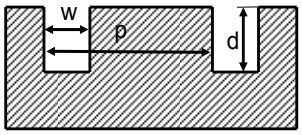


Fig. 1 a) discrete track disk. b) discrete track disk parameters.

The air bearing pressure over the slider is calculated based on the Reynolds equation [11], given by

$$\frac{\partial}{\partial x}\left(\bar{Q}ph^3\frac{\partial p}{dx}\right)+\frac{\partial}{\partial y}\left(\bar{Q}ph^3\frac{\partial p}{dy}\right)=6\mu\left(U\frac{\partial ph}{dx}+V\frac{\partial ph}{dy}\right) \qquad (1)$$

where *Q* denotes the Boltzmann correction for rarefied gas flow [12, 13], *p(x,y)* describes the pressure field of the air bearing slider, μ is the dynamic viscosity of air, while *U* and *V* are the velocity components in the *x* and *y* directions, respectively. The spacing between slider and disk is represented by *h*.

Simulation Results

In Figure 2, the pressure distribution for the trailing edge center region of a pico slider is shown for a) a smooth head/disk interface, b) an interface with 15nm groove depth, and c) an interface with 75nm groove depth, respectively. A coarse track pitch of 10µm and a groove width of 7.5µm were chosen, resulting in a groove width to pitch ratio of three to four (0.75).

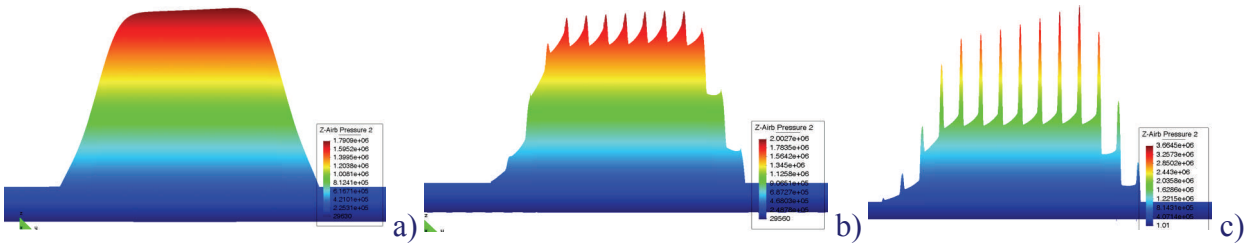


Fig. 2 Trailing edge center pressure distribution for a) smooth disk, b) 15nm groove depth, c) 75nm groove depth.

The trend in the pressure distribution of the air bearing surface for increasing groove depths can clearly be observed. With increasing groove depth, the pressure distribution over a land region approaches more and more the shape of a delta function, i.e., increasingly higher pressure values over the land regions are observed, accompanied by a decrease in pressure over the groove regions. As the pressure over a land region increases, side flow from the land areas into the grooves increases. Increased side flow results in a reduction of the maximum achievable load carrying capacity of the air bearing. Clearly, side flow and maximum pressure are important parameters that need to be considered in the air bearing design process for discrete track disk interfaces.

Experimental Testing

A spin-stand test system was used for testing the flyability of sliders on patterned media . Pico-type standard sliders (11 nm flying height) and DTR-specific sliders were used on the spin stand with integrated laser Doppler vibrometer (LDV) and acoustic emission (AE) signal capability for contact detection at the head/disk interface. To characterize the dynamic behavior of the sliders on the varying media, we have determined the standard deviation (STD) of the flying height variation. In Figure 3, the results of this calculation are shown for both standard and DTR sliders on each patterned media that was investigated..

As can be seen from Figure 3, there is a clear trend towards increasing variation in flying height with an increase in DTR groove depth. Since flying height variation should be less than 10-15% of the total flying height, the flying height variation as a function of groove depth appears to be a critical design parameter for discrete track media. Magnetic SNR tends to improve with increasing groove depth, but a groove depth that is too large may cause non-optimal variations in the slider flying height. Clearly, further research is necessary to fully understand how the flying height is affected by the DTR topology.

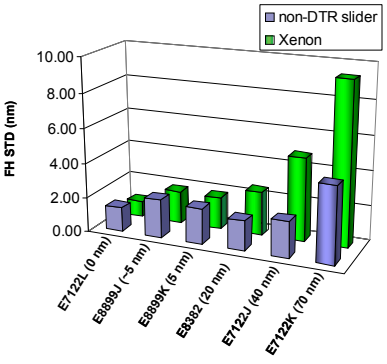


Fig. 3 Comparison of standard deviation of flying height variation for sliders

Summary and Conclusion

The influence of discrete tracks on the steady state flying behavior of sub-ambient air bearing designs was investigated. It was found that the maximum pressure in a discrete track media head/disk interface increase with increasing groove depth and increasing ratio of discrete track groove width to discrete track groove pitch. Also, experimental tests showed that increasing groove depth was found to increase the variation in slider flying height, indicating

(Continued on page 11)

Invited Talks and Recent Papers

Professor Emeritus Ami E. Berkowitz

Hong JI, Leo T, Smith DJ, Berkowitz AE. **Enhancing exchange bias with diluted antiferromagnets.** *Physical Review Letters, vol. 96, no. 11, pp. 117204-1-4, 2006.*

Berkowitz AE, Kodama, RH. **Exchange Anisotropy**, in "*Nanomagnetism 1; Multilayers, Ultrathin Films, and Textured Media,*" eds., J. A. C. Bland and D. L. Mills (Elsevier, 2006).

Professor Emeritus H. Neal Bertram

Goll D, Macke S, Berkowitz AE, Bertram HN. **Magnetic ground states and the role of vortices in ferromagnetic hollow nanospheres.** *Physica B, vol. 372, no. 1-2, pp. 282-5, 2006.*

Bertram HN, Takeo A, Jin Z, Fu C. **Transition shape analysis from medium noise measurements**. *IEEE Transactions on Magnetics*, *vol. 42, no. 5, pp. 1620-5, May 2006*.

Z. Wu Z, Siegel PH, Bertram HN, Wolf JK. **Design curves and information-theoretic limits for perpendicular recording systems,** *Proc. TMRC 2006, to appear in IEEE Transactions on Magnetics, February 2007*.

Professor Sungho Jin

AuBuchon JF, Chen LH, Gapin AI, Jin S, Tang YJ, Ye XR. **CoPt patterned media in anodized aluminum oxide templates.** *Journal of Applied Physics, vol. 99, no. 8, pp. 08G902-1-3, 2006.*

Tang YJ, AuBuchon JF, Chen LH, Jin S, Kim JW, Kim YH, Yoon CS, **Fabrication and magnetic properties of nanopatterned FePt media.** *Journal of Applied Physics*, *vol. 99, no 8, pp. 08G909-1-3, 2006.*

Daraio C, Nesterenko VF, Herbold EB, Jin S. **Tunability of solitary wave properties in one-dimensional strong nonlinear phononic crystals.** *Physical Review E, vol. 73, pp. 026610-1-10, 2006.*

Daraio C, Nesterenko VF, Herbold EB, Jin S. **Energy trapping and shock disintegration in a composite granular medium,** *Physical Review Letters, vol. 96, pp. 058002-1-4, 2006.*

Professor Paul H. Siegel

Chaichanavong P, Siegel PH. **Tensor-product parity code for magnetic recording.** *IEEE Transactions on Magnetics, vol. 42, no. 2, pt. 2, pp. 350-2, Feb. 2006.*

Chaichanavong P, Siegel PH. **Tensor-product Parity codes: combination with constrained codes and application to perpendicular recording.** *IEEE Transactions on Magnetics, vol. 42, no. 2, pp. 214-19, Feb. 2006.*

Han J, Siegel PH, **On the stopping redundancy of MDS codes**, *Proc. 2006 IEEE Int. Symp. Inform. Theory (Seattle, WA), pp. 2491-2495, July 2006.* (Also accepted to IEEE Transactions on Information Theory.)

Taghavi-N MH, Siegel PH. **Adaptive linear programming decoding**, *Proc. 2006 IEEE Int. Symposium. Information Theory (Seattle, WA), pp. 1374-1378, July 2006*.

Han J, Lee P, Siegel PH. **On the probability of undetected error for over-extended reed-solomon codes**, *IEEE Transactions of Information Theory, vol. 52, no. 8, pp. 3662-3669, August 2006.*

Professor Frank E. Talke

Jayson EM, Talke FE. **Optimization of air bearing contours for shock performance of a hard disk drive.** *Transactions of the ASME. Journal of Tribology, vol. 127, no. 4, pp. 878-83, Oct. 2005.*

Zhang J, Su L, Talke FE. **Effect of surface texture on the flying characteristics of pico sliders.** *IEEE Transactions on Magnetics, vol. 41, no. 10, pp. 3022-4, Oct. 2005.*

Deoras SK, Talke FE. **The use of system identification methods to evaluate the effects of slider-disk contacts and disk micro-waviness on the flying height modulations.** *Transactions of the ASME. Journal of Tribology, vol. 128, no. 2, pp. 341-4, April 2006.*

Raeymaekers B, Taylor RJ, Talke FE. **Non-contact tape tension measurement and correlation of lateral tape motion and tape tension transients.** *Microsystems Technology, vol. 12, pp. 814-821, 2006.*

Professor Jack K. Wolf

Demirkan I, Wolf JK. **The depth-first algorithm for designing 2-D single-state block codes.** *Proceedings IEEE International Conference on Communications (ICC'06), pp. CT0605, June 2006.*

Demirkan I, Siegel PH, Wolf JK. **Error event characterization of 2-D ISI channels.** *ISIT 2006, pp. 1095-1099, July 2006*.

Aviran S, Siegel PH, Wolf JK. **Optimal parsing trees for run-length coding of biased data.** *ISIT 2006, pp. 1495-1499, July 2006.*

CMRR Research Review

The Spring Research Review held May 4-5, 2006 was a well attended success. Over fifty people from CMRR Industrial Sponsor companies and other invited guests participated in the meeting, including several who participated via teleconference.

In addition to the sessions devoted to technical presentations of CMRR research results, the Review featured a special presentation by **Dr. Bruce Terris of Hitachi GST** entitled, "Patterned Media: Technology Overview and Island Reversal Properties."

CMRR Sponsor company employees may access the abstracts and viewgraphs of all Research Review presentations on the CMRR website in the Sponsor Resources section at http://cmrr.ucsd.edu/sponsors/subpgset.htm Contact Jan Neumann with any questions regarding Sponsor Resources at jneumann@ucsd.edu .

The Fall 2006 Research Review and Advisory Council Meeting will be held on October 11-12, 2006. For further information on the Fall Review, please contact Betty Manoulian at 858-534-6707 or bmanoulian@ucsd.edu

Graduate Students & Researchers Near Completion

Student	Level	Advisor	Dept	Research	Completion
Sharon Aviran	Post doc	Siegel/Wolf	CMRR	Coding and detection for page-oriented digital recording channels	June 2007
Maik Duwensee	Ph.D	Talke	MAE	Patterned media and discrete track recording	2007
Aravind Murthy	Ph.D.	Talke	MAE	Head/disk interface simulation, shock modeling of operational and non-operational head disk interface, textured and patterned media	2007
Bart Raeymaekers	Ph.D.	Talke	MAE	Head tape mechanics studies (LTM, dual stage actuator, friction and tribology)	2007
Jianfeng (John) Xu	Ph.D.	Talke	MAE	Head/disk interface, near contact recording, simulation tribology	2007

Graduate Degrees Awarded

Joseph AuBuchon, a Materials Science and Engineering student in Professor Sungho Jin's lab received his Ph.D. in spring 2006. Joseph's dissertation was entitled "Control of Carbon Nanotube Growth Directions by Direct Current Plasma Enhanced Chemical Vapor Deposition." This research demonstrated the ability to precisely control the growth directions of CNTs, the creation of sharp bends and zigzag structures, and the creation of 3D structures, such as coils. Following graduation, Joseph accepted a position as a Process Engineer in an atomic layer deposition group at Applied Materials in Santa Clara, CA.

Sharon Aviran, a member of both Professor Siegel and Wolf's groups, received her Ph.D. in July 2006. Her dissertation was entitled "Constrained Coding and Signal Processing for Data Storage Systems." Her research focused mainly on two topics: the design and analysis of efficient codes for one-dimensional and two-dimensional constraints, and iterative decoding and detection techniques for magnetic recording channels. She holds a postdoctoral researcher position at CMRR, working with Professors Siegel and Wolf. Her current work involves investigating machine learning algorithms for signal processing in the context of storage systems.

Chiara Daraio, a member of Professor Sungho Jin's group, received her Ph.D. in June 2006. Her dissertation was entitled "Design of Materials Configurations for Enhanced Phononic and Electronic Properties." She is now an Assistant Professor at the California Institute of Technology (Caltech) in the Aeronautics and Applied Physics Departments. Her current research interests reside in the design, development and testing of multi-scale metamaterials; phononic crystals; responsive soft matter; tunable acoustics; highly nonlinear solitary waves; mechanical and electronic properties of nano and biomaterials; advanced characterization of materials (high resolution TEM, in-situ analysis, FIB, AFM); synthesis, fabrication and assembly of nanomaterials and composite nanostructures.

Ismail Demirkan, a member of Professor Jack Wolf's group, received his Ph.D. in June 2006. His dissertation was entitled "Coding and Detection for 2-Dimensional Channels." His research involved the modeling and detection of 2-D holographic data storage channels and the design of codes for 2-D constrained systems. Ismail is currently employed in the Read Channel Architecture Group at Broadcom Corporation in Longmont, Colorado.

Lucas Fornace, a member of Professor Talke's group received his Master's degree in June 2006. His thesis was entitled "Weight Reduction Techniques Applied to Formula SAE Vehicle Design: An Investigation in Topology Optimization." Lucas is currently employed at a San Diego biotechnology company.

Tom Pisanic, a member of Professor Sungho Jin's group received his Ph.D. in September 2006. His dissertation was entitled "Tailored Magnetic Nanoparticles for *In Vitro*, *In Vivo* and *In Situ* Magnetorelaxometry." At UCSD he established the physical set up and the general research direction for the biological lab of Professor Sungho Jin. He investigated the cytotoxicological effect of magnetic nanoparticles upon PC12 cells and their ability to respond to biochemical cues. Tom is currently employed at Magnesensors, Inc. as a Lead Biomedical Engineer.

Visitors

Karsten Breddermann is a visiting student in Professor Talke's lab for the academic year 2006/2007. Karsten is here on a scholarship from the German Academic Exchange Service (DAAD). In 2003, he joined the mechanical engineering program at the University of Rostock . In 2005, he passed his pre-diploma successfully, specializing in ocean engineering. Outside of the lab Karsten enjoys sailing and American football.

Federica Garin is a visiting student from Italy in Professor Paul Siegel's group. She has received her Bachelor and Master's degrees in applied mathematics from the Politecnico di Torino. She is currently a 2nd year Ph.D. student at Torino under Professor Fabio Fagnani. Her research area is error correcting codes. She is particularly interested in non-binary codes, where the alphabet is a ring or a group, for application to non-binary modulations

Martin Gassmann is a graduate student on scholarship from Germany. He is currently exploring research opportunities in Professor Talke's lab at CMRR. Martin graduated with his Intermediate Diploma from University of Rostock in electrical engineering in 2005. After graduation, he focused on automation technology. He will study at UCSDfor the academic year 2006/2007 and when he returns to Germany he will complete his degree in Automation Technology. When not in the lab, Martin enjoys astronomy, sailing and traveling.

Robert Pfannenschmidt is a visiting student in Professor Talke's lab for the academic year 2006/2007. Robert is here on a scholarship from the German Academic Exchange Service (DAAD). In 2003, he entered the mechanical engineering program at the University of Rostock . In 2005, he passed his intermediate diploma with a specialty in naval architecture and ocean engineering. Outside of the lab, Robert enjoys sailing, surfing, and traveling.

Sara Zare is a new visiting student in Professor Talke's lab. She holds a B.Sc. in Biomedical Engineering from Shahed University in Tehran, Iran. She is currently working on her M.Sc. at The Leibniz University of Hannover, in Germany. Her Master's thesis is entitled "AFM Measurement of Intermolecular Forces Between Surfaces." Outside of the lab, Sara enjoys all kinds of music, especially traditional Persian music. She plays the daff, a Middle Eastern instrument, professionally. She also enjoys reading, cycling, jogging, swimming, and plans to enroll in a surfing course in San Diego. In the coming months she hopes to visit other cities in the USA.

New Staff

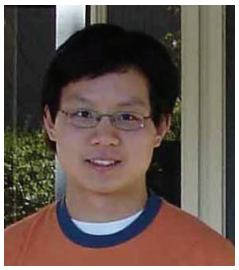
CMRR welcomes a new addition to the administrative team, **Michael Fung**.

Michael was previously employed at UCLA where he was responsible for coordinating research grant proposals and budgets. He also worked as an accounting assistant at various private companies in northern California. Michael is happy to be back in the UC system and to live in America's finest city - San Diego.

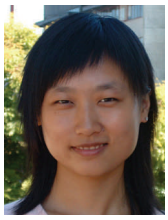
New Graduate Students

Karla Brammer has joined Professor Jin's research group as a new Ph.D. graduate student in the Materials Science and Engineering Program. She has a joint appointment with Professor Jin and Professor Leffert, from the Pharmacology Department, in the School of Medicine. Her research emphasis is on biomaterials and magnetic particles. In June, she graduated from Ohio State University with a B.S. in Materials Science and Engineering, specializing in biomaterials, and a minor in Biomedical Engineering. She spent this past summer exploring the molecular biology side of research by characterizing the growth property of cells on biomaterials. As a recent alumnus of Ohio State, Karla enjoys watching Buckeye football every Saturday. She also enjoys outside activities, especially the beach, and aerobic classes.

Kunbae (Kevin) Noh is a new graduate student from Seoul, Korea in Professor Sungho Jin's research group. His research interest is patterned media using anodized aluminum oxide (AAO) templates. He received his B.S. and M.Sc. degrees in materials science and engineering from Seoul National University in Korea. Since 2003, he has been working at Samsung Cheil Industries, Inc. and is currently supported by the company while he earns his Ph.D. Outside of school, Kevin enjoys listening to music, playing video games and traveling. He also wants to learn how to surf and play golf while in San Diego.



Hao Wang is a new member of Professors. Jack Wolf and Paul Siegel's groups. Currently, he is working toward his Ph.D. on patterned media and related coding theory topics. He received his B.E. from Tsinghua University in China, in 2005. His publications include "On the Efficient Implementation of Pipelined Heaps for Network Processing," accepted for Globecom 2006, and "Pipelined van Emde Boas Tree: Algorithms, Analysis, and Applications," submitted for Infocom 2007. He enjoys swimming, running, surfing (of course, it's California!!!), and meeting new friends.

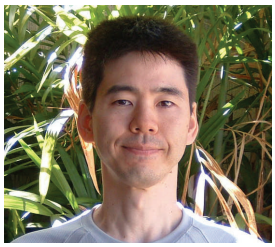


Hao Zheng has joined Professor Talke's group as a new graduate student. She received her B.S. degree from Beijing University of Technology, China, where she majored in thermal and energy engineering. Her specialization is in automotive engineering. Her current research interests are simulation and mechanical design.

Industrial Visitor

CMRR welcomes Dr. **Akihiro Inomata** from Fujitsu labs in Atsugi, Japan. Akihiro will be working with Professor Sungho Jin on patterned media fabrication, evaluation of magnetic properties, and study of recording physics.

At Fujitsu, Akihiro was involved in the pioneering and extensive studies of "Synthetic Ferrimagnetic Media (SFM)" which contributed to the 56 Gb/in^2 areal density demonstration in 2000 and the 106 Gb/in^2 demonstration in 2001 for which he received a Presidential Prize from Fujitsu.



Akihiro has published over 35 papers and given more than 50 presentations. He has three US patents and nine in process and one Japanese patent and 14 in process.

In 2006, he was awarded the 52nd Okochi Memorial Grand Production Prize for the development and commercialization of exchange-coupled media (SFM).

Welcome Akihiro!

Grants

Professor Talke received an equipment grant from the Office of Naval Research/DURIP program to purchase a scanning vibrometer from Polytech for the measurement of the brush dynamics of the homopolar motor. The vibrometer will complement his previous AE studies of the brush/rotor interface. In addition to being a new powerful instrument for the homopolar motor studies, the scanning vibrometer can be used to measure the dynamics of any moving body. We are delighted about this new piece of high precision instrumentation.

Research Highlight *(Continued from page 5)*

that groove depth is a critical design parameter for discrete track media. It is likely that there is an optimal groove depth that yields an optimal SNR for magnetic recording and is acceptable from the point of view of flying height variations.

Acknowledgement:

This research was partially supported by a grant from the Information Storage Industry Consortium (INSIC).

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Summer Internships

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Ralf Brunner, a graduate student of Professor Talke, worked this summer at SISA, Samsung Information Systems America in San Jose, CA. His project included research on carbon overcoats and lubrication issues in the head-disk interface and hard disk drives. Several experiments using different characterization techniques were performed. DOE (Design of Experiments) was used for a systematic approach to quality and product issues in the reliability sector.

Chulmin (Edward) Choi, a graduate student of Professor Sungho Jin, traveled to Korea for a 2-month internship with SISA, Samsung Information Systems, where he conducted research in the area of magnetic recording media structure fabrication.

Junsheng Han, a graduate student of Professor Paul Siegel, did a 2-month internship with IBM Research at IBM's Yorktown Heights, NY facility. His work included:coding for memory systems and design of codes for correct specific failure patterns.

Mohammad Hossein Taghavi, a graduate student of Professor Paul Siegel, spent 3 months as an intern with DSP (Digital Signal Processing) Group in Minnesota. The internship involved simulation and performance analysis of wireless 802.11n transmitters. The issues studied included coding and modulation in MIMO-OFDM systems.

Zheng Wu, a graduate student of Professor Siegel and Wolf spent the summer at **Seagate Technology** in Fremont, CA. Her work included research on the optimization of channel parameters based on measured signal and noise characteristics.

Jianfeng (John) Xu, a graduate student of Professor Talke, did an internship with Yiao-Tee Hsia of **Seagate Technology** in Pittsburgh, PA. Jianfeng's work involved the experimental study of slider dynamics when flying at ultra-low flying height.

Yeoungchin (Paul) Yoon, a graduate student of Professor Talke, traveled to Korea for an internship in the area of head and disk interface at Samsung Electronics.

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