TMRC 2005 REVIEW

Harry Gill, Conference Chairman, TMRC2005

16th Annual Magnetic Recording Conference (TMRC 2005) was held at the Stanford University, California, from Aug. 15 to 17. The main topics for the conference were **Heads and Systems**. This included Read Head, Write Head, Perpendicular recording heads and systems, Recording systems, Advanced coding/detection and Reliability/Mechanics.

The conference was a huge success with 406 registrants, the largest attendance in the history of this conference. On Tuesday evening, Mark Kryder, CTO, Seagate Technologies, discussed future technology options for the magnetic recording industry. In his view, conventional Perpendicular magnetic recording is limited to about 0.5 Tbit/sq inch areal density. Heat Assisted Magnetic Recoding (HAMR) and Patterned media options are expected to be required beyond 0.5 Tbit/sq inch areal density point.

The technical sessions were well represented by both the industry and the universities. There were 36 invited talks with authors from 23 institutions: ActionFront Data Recovery Labs, Agere systems, Alps, Anelva, ChannelScience, Fujitsu, Headway, Hitachi, Hutchinson, Matsushita, Maxtor, Panasonic, SAE, Seagate, Sony, StorageTek, TDK, Toshiba, UC Berkeley, CMU/DSSC, UCSD/CMRR, Data Storage Institute Singapore and Harvard. Along with these invited papers, 16 Poster submissions were also presented in two day very popular poster sessions which accompanied by Bierstube were highly enjoyed by the attendees. The authors for Poster only papers were from additional 21 institutions: Universita di Ferrara (Italy), Universita di Brescia (Italy), Akita Institute of Technology (Japan), Waseda University (Japan), Tandberg Storage (Norway), Moscow State University, Kharkov Politechnical Institute (Ukraine), Samsung, The University of Alabama, Unversity of Limerick (Ireland), Ruterges University, Univ. of Cambridge, Stanford Unversity, National Taiwan Unversity, Imago Scientific Instruments Corp., Toshiba, Unversity of Toledo (Ohio), National Unversity of Singapore, Niigata Institute of Technology (Japan), Kogakuin University (Japan). Such a diverse representation from both the industry and the universities from around the globe confirm the international nature and popularity of this conference.

TMRC 2005 conference clearly showed transition to the CPP sensors and the Perpendicular recording.

The papers A-1 (TDK,"A performance study of next generation's TMR head with advanced design") and F-1 (SAE,"Reliability of Tunneling MR recording head—Lifetime, Failure mode and Production screening") on Tunnel MR heads demonstrated performance and reliability of these heads. One notable result from paper F-1 (SAE) is that the short lifetime heads can be screened by using appropriate limits for %dMRR change (head resistance change between high and low current). More positive resistance change implies that the TMR barrier has a larger metallic shunt path in the barrier. These are the heads found to have shorter lifetime. Also discussed were reversible resistance

change of the head discussed due to charge trapping and then charge release causing time dependent changes in head resistance and output signal. Anelva Corp. (paper A-3,"Huge MR and low RA in magnetic tunnel junctions with crystalline MgO barrier") showed optimization of the CoFeB/MgO/CoFeB type Tunnel MR sensor. It was shown that near zero magnetostriction and TMR near 100% is achievable using Co64Ni11Fe6B19 type free layer. Seagate (paper A-2, "Characterization and integration of TMR heads in high capacity Hard disk drives") demonstrated use of Tunnel MR heads in disk drives and also claimed that these heads can be produced without 1/f type head noise, however, it offered no barrier composition or other design/process details required to eliminate or screen the heads with 1/f noise. There were four papers on CPP GMR heads. Alps (paper A-5,"Narrow track width CPP spin valve heads utilizing Half-Metallicity materials") claimed superior performance, dR/R = 11 %, for the all metal dual CPP GMR heads containing reference/free layers of half-metallicity materials. Extension to smaller area sensors with this structure as compared to the Tunnel MR is the major motivation due to limitations of Tunnel MR for high data rate applications. Alps also compared performance of this CPP GMR sensor against Tunnel MR made from TiOx barrier and demonstrated that CPP GMR achieves performance similar to Tunnel MR but with much lower RA product. These CPP GMR heads with track width of 70 nm exhibited spectral SNR of 15 dB and bit error rate comparable to CIP GMR heads. A paper from Hitachi (paper B-2,"Mag-noise fluctuations in CPP GMR read heads") on the CPP GMR demonstrated that the reference layer instability caused by the spin torque likely sets sense current limits for the all metal dual CPP GMR operating under large sense current. A paper by Fujitsu (B-6,"Ultra high magnetic moment films for write head"), showed larger saturation magnetization (near 2.57 T) for the Co30Fe70/Pd superlattice films for the write pole application.

Several speakers demonstrated areal density beyond 200 Gbit/sq inch using Perpendicular recording technology. Hitachi (Paper C-1,"Head challenges for Perpendicular recording at high areal density") demonstrated areal density near 230 Gbit/sq inch using Perpendicular recording disk and CIP GMR read heads. Seagate (paper A-2) demonstrated areal density near 254 Gbit/sq inch using Perpendicular recording disk and Tunnel MR heads. Toshiba (paper D-1,"Perpendicular drive integration") described Perpendicular magnetic recording drive integration.

Several other papers discussed important new technologies for the magnetic recording industry. Poster submission from Akita Institute of Technology titled "Novel shielded single pole head with planar structure " by Ise et al., showed novel head structure exhibiting smaller drop in head field as the shield yoke height is increased compared to conventional single pole heads. Another poster submission from Akita Institute of Technology and Waseda university titled "Controlling magnetic domain structures for the core of the Cusp-field single pole head" by Yamakawa et al., showed yoke/shield design to achieve favorable domain structure which is required for high magnetic stability and high frequency performance. A paper (F-5,"Demonstration of external shock resistance greater than 2000 G during R/W operations on a 0.85 inch HDD with balanced type head suspension") from Matsushita/Panasonic demonstrated suspension design exhibiting greater than 2000 G external shock resistance. A paper (F-3,"Some air bearing slider

designs for areal density of 1 Tbit/sq inch) from UC Berkeley showed several slider designs suitable for 1 Tb/ sq inch magnetic recording. Several invited papers on the novel coding/detection schemes were also presented.