Reducing information stored in magnetic thin films to the size of single grains could improve computer hard drives

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Even more data is set to be packed into the magnetic thin films of computer hard drives, thanks to modeling research at A*STAR. Credit: Stockbyte/Thinkstock

Despite the increasing competition from alternative technologies such as solid-state drives, magnetic disks remain an important data-storage technology. They are not only reliable and inexpensive, but their storage density has potential for even further improvement. One method under current investigation is storing each data bit in a single magnetic grain of the thin film of the recording medium, rather than in several grains as in conventional hard drives. Storage in single grains only would increase stability and reduce the magnetic fields required to write bits.

By modeling write processes in hard disks, Melissa Chua and her co-workers at the A*STAR Data Storage Institute, Singapore, have demonstrated how this is possible in practice. "The hope is that such a grain-based magnetic recording can extend storage densities by an order of magnitude, to achieve ten terabits per square inch," she says.

Thin magnetic films for data storage coat the top layer of plastic films in hard-disk drives and consist of many neighboring nanometer-sized grains. As storage density of magnetic films has increased over the years, the surface area used for storage per bit is now comparable to the size of these grains.

Achieving single-grain storage requires a solid understanding of the write processes. Two theoretical models are available to describe these processes. One is an analytical model that uses a simplified description of the magnetic fields within the grains and within the write head of the hard disk. This model achieves fast and easy-to-implement modeling of the recording process, Chua notes.

The second model is a statistical approach that uses tabulated values of parameters that detail the magnetic orientation switching process when information is written to the hard disk. These parameters are derived from detailed simulations of the magnetic fields in the grains and from the computer hard drive write head. From these, the researchers produced a probability for a grain to switch under given circumstances. This detailed approach is more accurate, but also more time intensive than the analytical approach.

Chua and her co-workers successfully applied both models to the grain-based storage process. They simulated the switching of single grains with both methods and then compared their individual performance. By adjusting relevant process parameters for both models, they achieved good agreement between them. Having shown the suitability of both

models, choosing which model to use depends on specifics, such as the desired accuracy. Either way, Chua says, "Both models enable the system-level testing of future magnetic recording technologies."

More information: Chua, M., Elidrissi, M. R., Eason, K., Zhang, S. H., Qin, Z. L. et al. Comparing analytical, micromagnetic and statistical channel models at 4 Tcbpsi patterned media recording. *IEEE Transactions on Magnetics* 48, 1826–1832 (2012). ieeexplore.ieee.org/xpl/articl … ontentType=Journals+%26+Magazines

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