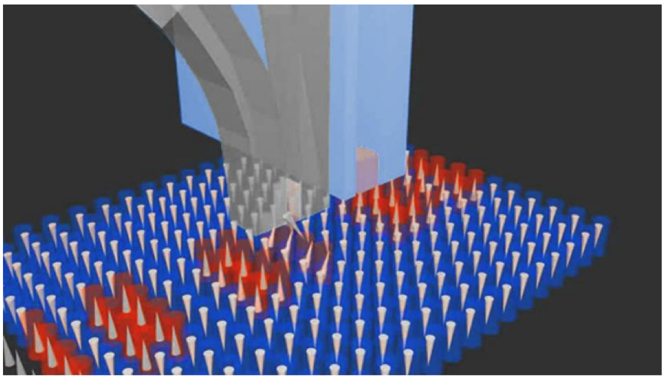
TOSHIBA

HAMR vs. MAMR

Microwave technology delivers higher storage densities in hard disks



We are generating more and more data which needs to be stored safely and effectively. Hard disk drives (HDDs) continue to be central to solving this challenge, requiring them to be available with increased storage capacities. In order to provide the necessary technical solutions, engineers are now looking to incorporate microwave-based technologies into HDDs.

As cloud services, video streaming and social media continue to increase in popularity data volumes are growing rapidly, challenging data centers to grow their storage capacities to cope with demand. As a result, many large IT companies are planning to add additional data centres to drive capacity higher.

Ideally, data centers want to deliver the enhanced capacity within the same footprint as real estate is expensive. For HDD manufacturers, this means that they must develop and deliver HDDs with ever-increasing storage capacity. Moving from 12 / 14TB to 16 / 18TB capacity drives can make a significant difference, potentially saving storage servers or entire racks. This approach allows existing data centers to rapidly increase capacity if the basic infrastructure remains adequate.

Delivering higher capacity HDDs in the same format requires designers to increase recording density. To achieve this, technologies such as microwave assisted recording and laser assisted recording are being explored.

Higher storage densities require new technologies

Increasing storage capacity involves several challenges. In particular, increasing recording density means that more bits are stored in the same area implying the use of material that is more difficult to magnetise or modify, although this is necessary for safe long-term data storage. As a consequence, additional energy is required to 'flip' (i.e. change them from 0 to 1 or vice-versa) the magnetic bits during writing. As a result, the size of the write head cannot be reduced below a minimum size, which in turn limits the storage density. If write heads are made smaller to accommodate more tracks on the disk, they are no longer strong enough to magnetise bits.

To address this challenge, there are currently three competing technologies: Singled Magnetic Recording (SMR), Heat-Assisted Magnetic Recording (HAMR) and Microwave-Assisted Magnetic Recording (MAMR).

The simplest approach is SMR, which deliberately overlaps the magnetic recording tracks, rather than using side by side tracks to increase data density. This is possible because the read head is much narrower and smaller than the write head, and as long as the non-overlapped area of a track is wide enough for the narrow

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read head, data case be safely read. However, a random writing in overlapping tracks may cause earlier writes to be deleted and rewritten. In practice, a set of overlapping tracks has to be read first, then modified in the memory buffer, and than written back to the media, this can mean lower write performance and slower writing speed, so that the SMR procedure is only suitable for purely sequential archiving tasks in the enterprise segment.

HAMR is another potential solution to address the need for higher storage densities as it uses a laser diode for heating up the media area where data should be written to, supporting the writing process through the selective use of heat energy. This allows writing with less magnetic energy and the use of a smaller write head, achieving a higher storage density as a result. However, the energy requirement has an impact on the operating costs in large installations and also leads to thermal challenges. In addition, there are still concerns about the long-term reliability of laser diodes.

Another approach is MAMR which uses a microwave transmitter (spin torque oscillator) at the write head to generate waves in the range of 20GHz to 40GHz. These are introduced to the magnetic medium as auxiliary energy, thereby requiring less energy for the writing process. In turn, this means that significantly smaller writing heads can be used, making the production of drives with significantly higher capacity possible.

MAMR leads the way…

MAMR is based on a technology that has been tried and tested for many years, leading to it being considered an evolution in the development of writing heads. A variety of common techniques can be used without the need for additional components such as laser diodes. All that is required to implement MAMR is a different wafer design that allows the use of microwave technology. HDDs using MAMR technology are expected to have the same mean-time-to-failure (MTTF) performance and reliability as currently shipped products. The power requirements for HDDs using MAMR are also expected to be in line with current devices.

Compared to MAMR, HAMR will still require a significant amount of basic research, especially field research to precisely determine their reliability. As such, there is a tangible early-adopter risk with HAMR technology deployment.

Toshiba plans to introduce HDDs using MAMR technology within the proven 9-Disk Helium filled design increasing the capacity of currently 16TB with MAMR to 18TB.

Whatever power-assisted recording technology is used, disk capacity is sure increase, allowing HDDs to continue to be the technology of choice for cost-effective storage in a wide range of applications.

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