

CPP Read-Head Technology Enables Smaller Form Factor Storage

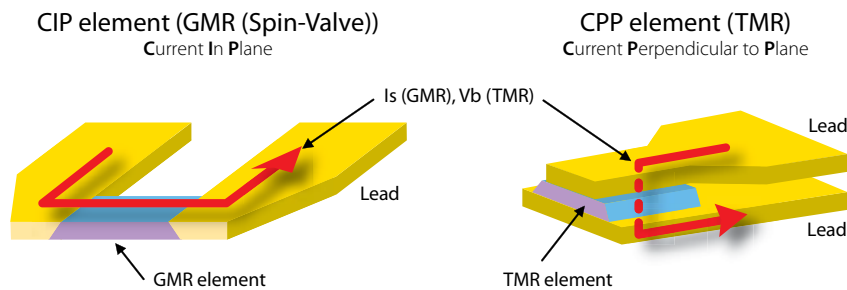
In order to realize a new generation of products with greater storage densities in smaller form factors, the technologies for the storage media and the read- and write-heads of the storage devices must undergo major transformations. This document provides a topline on significant developments in read-head technology.

Since the late 1980's, hard disk drive storage technology has been built on the giant magnetoresistive effect (GMR). This uses the effect of free electrons between two layers of charged ferromagnetic material. In today's hard disk drives this is utilized in a read element design known as Current in Plane (CIP).

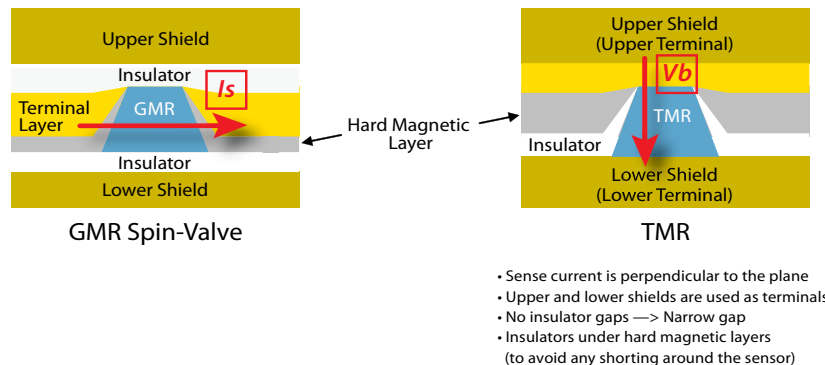
The tunnelling magnetoresistive effect (TMR)—an alternative to GMR—was discovered in 1975, followed by the discovery of room temperature TMR in 1995. TMR occurs when two ferromagnets are separated by a thin (about 1nm or 8 atoms) insulator that, under the right conditions, causes the free electrons to tunnel through the insulating barrier. The utility for non-volatile storage was quickly exploited for Magnetoresistive Random Access Memory (MRAM).

Because the effect depends upon on the physical proximity of the conductive layers and is bounded by the thickness of the insulating layer, the application potential in CIP designs had certain physical limitations. This had negative implications for its use in denser, smaller storage solutions. In order to make full use of the effect in mass storage applications, it was necessary to design an alternative physical architecture.

Fujitsu and a team of hard disk drive industries have developed a new read-head architecture called Current Perpendicular to Plane (CPP). CPP architecture exploits the TMR effect to increase the potential density of stored data and enable a reduction in the total size of storage devices employing the architecture.



By reorienting current flow perpendicular to the plane, the read element can be made physically smaller. This, in turn, can enable the development of higher capacity and smaller personal and portable end-products which utilize mass storage with capacities well beyond what has previously been possible.

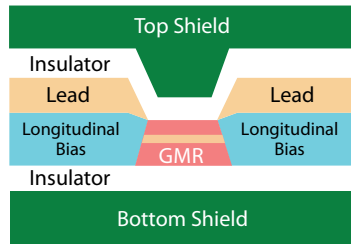


CPP architecture enables increased areal density in two ways:

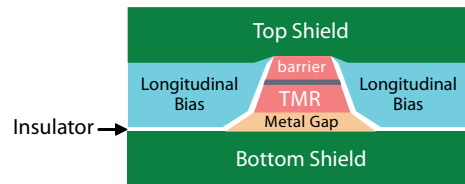
- ▶ The top to bottom current flow of the CPP element eliminates the need for an insulator gap. As a result, the read element becomes more sensitive and can be used on higher Bit per Inch (BPI) designs.
- ▶ The use of the shield as the upper and lower terminal puts it in direct contact with the TMR element. This prevents cross talk with adjacent tracks, thus enabling an increased number of Tracks per Inch (TPI)

The smaller physical size and higher sensitivity combine to reduce the overall physical size of the device.

GMR Heads (CIP Structure)



TMR Heads (CPP Structure)



Advantage of TMR Heads structure:

1. Can reduce shield gap as low as 25nm level → Higher resolution of BPI
2. Better topology of top shield → Side shield effect → Higher resolution of TPI

TMR head structure is more suitable for higher record density

Laboratory implementations have yielded CPP data error rates comparable to GMR architecture, indicating that CPP-based storage solutions have become a viable alternative to GMR-based products. This will enable the development of end products that require increased storage capacity and/or smaller form factors—such as personal or portable electronics.

CPP read-head architecture represents one of the elements necessary to produce higher density and reduced form factor of storage components. Fujitsu is continuing the development of these elements and plans to offer Tbits/sq. inch recording in the near future.

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