High-Pinning Iridium-Manganese-Chromium (IrMnCr) Read Sensors for High Reliability & Stability

Introduction

To fuel the continued growth in areal density of hard drives, the physical dimensions of the read sensor have had to be significantly reduced to accommodate the smaller data bit size (see Figure 1). This dramatic reduction of the read sensor—more than 10X in 10 years—has significantly increased the susceptibility of the read head to magnetic and environmental stresses and led to increased propensity for failure. Concurrently, consumers are requiring increased reliability with every generation of hard drives for storage of their valuable data. To address the demand for increased capacity and highly reliable operation of the read sensor, HGST scientists developed a novel material and process for the manufacture of ultra-small read sensors. Use of a new read-head alloy—iridium-manganese-chromium (IrMnCr)—resulted in the storage industry's most stable and reliable read-sensor technology.

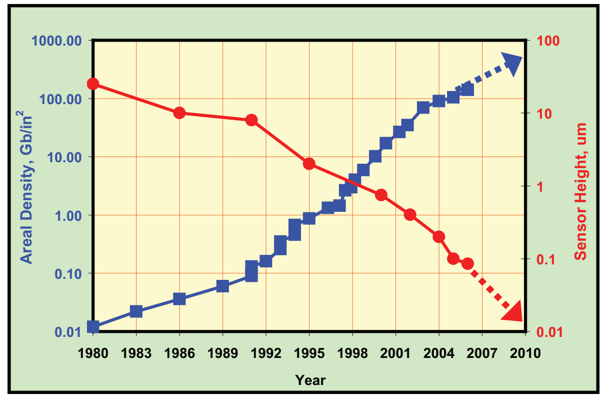


Figure 1: Areal density and sensor height vs time for longitudinal and perpendicular recording heads. Shorter read sensors have increased stress on the pinned layer and are more susceptible to environmental factors.

The IrMnCr alloy combination replaces the platinum-manganese (PtMn) alloy used in prior read-head generations. HGST added chromium to the combination to bring additional anti-corrosion properties to the read sensor. In combination with IrMnCr, HGST engineers incorporated an extremely thin layer of ruthenium in the structure to create a very high "pinning field" which affords increased stabilization of the read sensor.

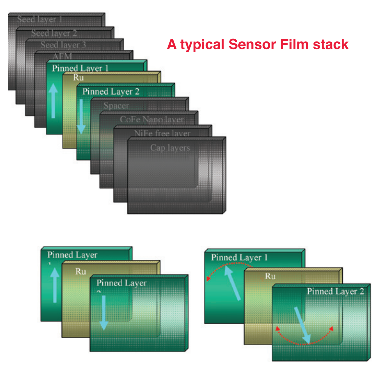


Figure 2: Schematic of a GMR read-sensor film stack. Lower right drawing shows pinned layer rotation (instability) due to thermal, mechanical, and magnetic field stresses experienced in the hard disk drive environment.

Figure 2 is a schematic diagram of a typical multilayer giant magneto-resistive (GMR) head which is composed of a pinned layer, spacer layer, and free layer. In order to have stable, reliable operation of the sensor, the magnetic orientation of the pinned layer must be fixed or held in position. This requires the pinned layer orientation to be robust or resistant to mechanical, thermal, and external magnetic fields from the disk drive environment, independent of its physical size. The stronger the pinning field, the more stable the read sensor. Figure 3 illustrates the results achieved by HGST's novel design and process, which provides not only a 2X increase in pinning field compared to previous sensors, but also a much more uniform pinning field.

The unique combination of pinning field strength and uniformity results in substantially higher reliability and increased manufacturing yield. Figure 4 shows the greater than 2X improvement in field reliability for hard drives using the new IrMnCr read sensor, and Figure 5 illustrates the 10 percent increase in hard drive yield. HGST notebook PC customers have confirmed the robustness of the new read sensor design, and believe it offers a higher level of protection to their end-users' data.

The new IrMnCr sensor is completely extendable to future head designs such as tunneling magneto-resistance (TMR), and it provides confidence that HGST will be able to meet the demands for increased capacity and high reliability hard drives.

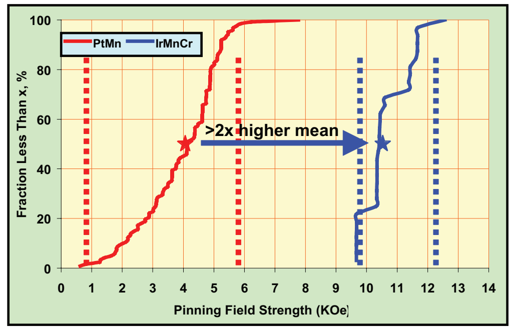
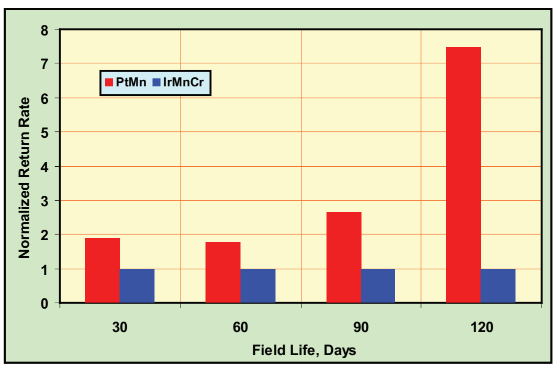
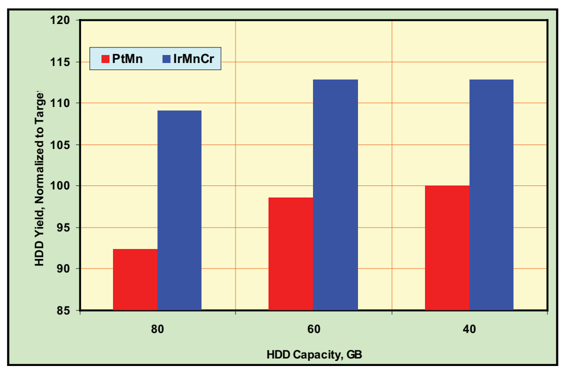


Figure 3: Pinning field distribution. The new IrMnCr sensor shows 2X higher pinning field compared to PtMn sensor and a significant advantage over nearest head competitor.

The development and conversion of our product lines to IrMnCr/Thin Ruthenium sensor structures is the result of a worldwide effort, involving many technologists and specialists in our Research, Ad Tech, Development, Manufacturing Engineering and Manufacturing operations. Our business is greatly indebted to all contributors for delivering this monumental technology to the HDD market place.





Figures 4 and 5: Hard drive normalized field reliability and yield data for IrMnCr and PtMn read sensors. Significant improvements in hard drive field reliability (greater than 2X and increasing with time) and an increase in manufacturing yield of ˜10% were obtained for all capacity models.

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