The Head/Disk Interface in Magnetic Recording: Current Challenges and Future Opportunities

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The head/disk interface (HDI) remains a critical element of magnetic recording in HDDs, increasing in importance as current head-media spacings (HMS) approach 10 nanometers and are projected to decrease to even lower values. While the relationship between a given HMS and the corresponding achievable density is quite fundamental, the technologies practiced and the ones being proposed to achieve a spacing point offer many choices and tradeoffs that need to be understood. At the same time, new solutions and technologies are being invented and evaluated in support of ultra-low magnetic spacings, many touching on state of the art understanding of surface science and of molecular level understanding of tribology and materials.

After a brief overview of current HDI technologies and a discussion of the importance of magnetic spacing and the approaches used for minimizing it, the talk will concentrate on present and proposed solutions to achieving magnetic spacings in support of future recording densities. At densities of 10^{12} bits (1 Tb) per square inch, or about an order of magnitude higher than today's products', spacings of 5-7 nm are projected to be necessary. This tight spacing budget will have to accommodate many of the classic HMS components, such as disk and slider overcoat thicknesses (if any), residual contributions from disk and head topographies, from lubricant thickness, the head flying height designed for achieving a minimum safe clearance, etc.

Analysts anticipate a crossing of the 1 Tb/inch^2 density threshold within a decade or less. Major technology shifts are expected to be necessary on the way to achieving terabit densities, most of them with some likely consequences for HDI tribology. These technological transitions include: (1) Perpendicular Recording with its implications for media composition, topography, thickness, etc. leading to possible changes in mechanical properties of the disk; (2) Discrete Track Media and/or Patterned Media with implications for head flyability and lubricant behavior through possible impact on surface morphology and topography; (3) Thermally Assisted Recording with conceivable implications for disk lubricant and media overcoat integrity due to the stress of rapid local heating and cooling of the media structure. The talk will review these implications in more detail and attempt to point out some of the possible solutions and their tradeoffs.