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Approaches and Applications of Tilted Magnetic Anisotropy in Hard Disk and STT-RAM Magnetic Recording for Extremely High Areal Density[1]

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Using tilted magnetic anisotropy in magnetic recording media has been proposed and demonstrated to address several key challenges for future hard disk magnetic recording several years ago. Recent simulations show the potential benefit of using tilted magnetic anisotropy in patterned composite magnetic media that can supports the recording areal density up to several Terabit per square inch. In this talk, I will first present the fundamental physics of the advantages of using tilted magnetic anisotropy in magnetic recording media and spin torque transfer random access memory (STT RAM). Then several approaches to experimentally make magnetic films with tilted anisotropy will be presented and discussed in details. These include 1) crystallographically controlling the tilted magnetic easy axis by using proper underlayers and seedlayers; 2) physically engineering the tilted magnetic easy axis by oblique sputtering on smooth or curved substrates; 3) mechanically engineering the tilted magnetic easy axis by self –assembling magnetic nanoparticles with special shape (such as octahedral-shaped L10 phase FePt nanoparticles); 4) micromagnetically engineering the titled magnetic easy axis by exchange-coupling two magnetic layers with different magnetic easy axis and anisotropy constant. Results based on hcp phase Co-alloy and L10 phase FePt and FePd films will be presented in details. Finally, I will propose and discuss how to use tilted magnetic anisotropy for the magnetic free layer in the magnetic tunnel junction (MTJ) to reduce the critical switching current density while keeping the thermal stability, which can extend the recording density of the proposed STT RAM further.

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