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The study of near field transducer performance through light behavior over the recording medium

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Abstract

The exceeding temperature at Near Field Transducer (NFT) is a mandatory issue in Heat Assist Magnetic Recording (HAMR). It significantly affects both system performance and lifetime. We believe that light reflection off the recording medium could contribute to the temperature rise in the NFT. In this paper, we study light behavior from the NFT output to the media in terms of powers, using 3-D simulation. We found that the light reflection off the recording layer has certain effects on media absorption rate and NFT coupling efficiency. An increase in the NFT temperature is partly induced by the reflected light. When the surface roughness is included, the reflected power to the NFT obviously decreases. The average absorption rate is reduced more than 50%. The maximum absorption rate and smallest coupling efficiency occurs at the roughness Ra = 0.55 nm.

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Keywords: recording head technology; near field transducer

1. Introduction

Heat Assist Magnetic Recording (HAMR) is one of recording technologies that is promising to be commercialized in near future. Active research topics on HAMR involves mainly on efficiency improvement. Near field transducer (NFT) is a critical component in HAMR. It helps confine and enhance the light into a sub-diffraction

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limited spot before coupling into the recording media. During these processes, light is confined to the NFT tip via surface plasmon phoenomena (LSP) and then propagates to the media. Some part of the light is absorbed by the media while some is reflected off the media. Increasing the input power and the induced LSP effect can probably cause the temperature rise that results in NFT damage, which leads to head failure[1,2]. Medium absorption and light reflection characteristics may thus be the important factors to determine efficiency of the NFT. Therefore, our goal in this research is to investigate the behaviors of light reflection absorption in NFT and recording media.

2. Modeling Parameters

We use an RF module in COMSOL Multiphysics, a Finite Element Method (FEM) simulator, to perform our modeling. The 3-D simulation model consists of 830 nm wavelength laser source placing on the top of Planar Solid Immersion Mirror (PSIM) waveguide[3]. The core and cladding are made from Tantalum pentoxide (Ta_2O_5) and Silicon dioxide (SiO_2). The core thickness is 100 nm. The gold (Au) lollipop NFT is placed near the core at the end of waveguide. The thickness of the NFT is 20 nm. The fly height (air gap) is varied between 2.5-5 nm. For the recording layer, 10 nm thick Iron Platinum (FePt) is chosen due to its high anisotropy characteristic. The 15 nm thick Magnesium Oxide (MgO) soft underlayer (SUL) is located under the recording layer offering stronger write field. The bottom layer is 80 nm thick gold which works as a heat sink. The schematic of the simulation model is shown in Fig. 1 (a) Optical properties of materials are shown in table 1. Note that, these values are determined at 830 nm.

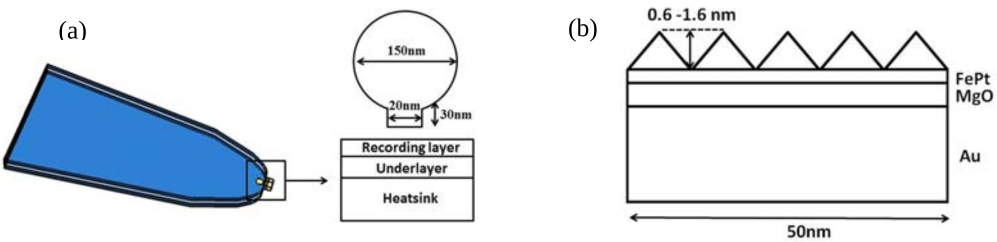

Fig. 1. (a) Schematic of PSIM with media; (b) Zoom in of recording medium with surface roughness

Table 1. Refractive index of materials[3]

Material	Refractive Index (*n*)
Tantalum pentoxide (Ta_2O_5)	2.11
Silicon dioxide (SiO_2)	1.46
Iron Platinum (FePt)	3.42+2.67i
Magnesium Oxide (MgO)	1.72
Gold (Au)	0.2+4.94i

To gain more understanding on light behavior, we also study the effect of medium surface roughness (Ra) shown in Fig 1 (b). The actual media surface contains some roughness; therefore, understand its relationship to light behavior can possibly improve the NFT efficiency and prevent thermal radiation. The roughness model is created by the uniform sawtooth profile defined in Eq. 1, where n is the length and Z_i is the roughness curve[4]. The base width of each triangle is 10 nm and the height is varied between Ra = 0.3–0.8 nm. These values are simply assumed to observe detailed response in the region of interest.

$$Ra = \frac{1}{n}\sum_{i=1}^{n}|Z_i| \quad (1)$$