TEMPERATURE INDUCED CHANGES IN THE OPTICAL AND MATERIAL CHARACTERISTICS OF HAMR MEDIA COC AND ITS EFFECT ON RECORDING PERFORMANCE

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I. INTRODUCTION

Heat Assisted Magnetic Recording (HAMR) makes use of temperature dependent changes in the magnetic storage layer to enhance the writing process [1]. This imminent technology uses light propagating from the AAB to transiently heat the magnetic film within a fixed area, to a target temperature and for a well-defined time. Thus the optimum thermal and optical properties of the entire media film structure are important for the successful implementation of the HAMR interface. Typically, a nano-thin carbon overcoat (COC) film is used to protect the surface of magnetic storage disks from chemical and mechanical degradations. In addition to these attributes, the HAMR COC optical properties are important for a successful HAMR recording film structure. In this presentation we focus our efforts on the influence of the COC on the quality of the HAMR recording. Specifically, the influence of the COC optical properties on the SNR of the written signal as a function of deposition temperature was probed. The change in optical indices with deposition temperature was correlated with Raman spectroscopic measurements that enabled a detailed understanding of the change in the COC structure with temperature. The required laser power to attain HAMR writing and the recording quality were both obtained with HAMR heads. A significant improvement in the written SNR was observed with increasing deposition temperature. A detailed FEM model of this optical/thermal recording system clarified that this SNR increase was due to an increasing media thermal gradient with increasing COC extinction coefficient.

II. RESULTS

The wavelength dependent optical properties of the materials at the head-disk interface are required for a full understanding of how light emanating from the near field transducer (NFT) interacts with HAMR media. The media films closest to the NFT, especially those having high optical extinction coefficient (k), are expected to absorb proportionately more of this incoming light. The optical properties of COC films are sensitive to the exact deposition process and significantly the deposition temperature. [2]. To probe the effects that the optical properties of the COC film has on the HAMR recording, we have deposited films onto media surfaces at increasing temperature. The extinction coefficient of these films (presented in Fig. 1) increase with media surface temperature, which is attributed to material changes in the COC at high temperature, for example: increasing sp^2 content [3]. As a consequence, a larger absorption ($4\pi k/\lambda$) takes place in this layer, incrementally increasing its temperature and allowing the media to attain its target temperature using lower laser power (see Fig. 1). This increased optical efficiency allows the use of approximately 8% lower laser power to attain HAMR writing over the approximately 250 ºC COC deposition temperature range investigated (see Figure 1). It is well known that HAMR writing is dominated by the thermal gradient of the heated spot and is an important consideration when designing the media [1]. A comprehensive FEM head and media model was assembled that incorporated both their optical and thermal characteristics to study the effect that changes in the COC layer have on the media thermal gradient. The thermal gradient calculated with this model increases approximately 10% over the range in k of the studied COC films (see Fig. 2). A measurement of the quality of the written signal on similarly deposited media spanning a smaller range in extinction, shows an incremental improvement of approximately 0.5 dB, thus further supporting the importance of the thermal gradient on HAMR recording physics and its manipulation using the COC optical film properties.

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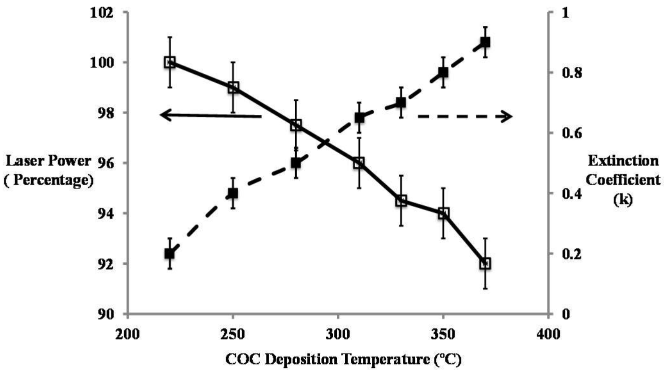

Fig. 1 The measured k (at 800 nm wavelength) of the COC films deposited at incrementally higher temperature and the laser power needed to attain HAMR writing, 100% is set with COC deposited at 220 °C.

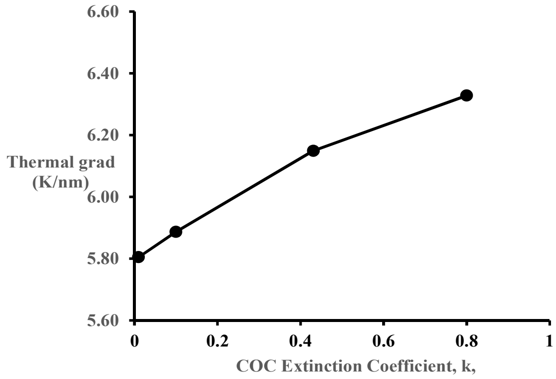

Fig. 2 The change in calculated thermal gradient in HAMR media due to increasing COC extinction coefficient.