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Elemental Mapping of Co-Pr Nanostructured Powders by EELS Image Filtering

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In current extremely high density recording media design, the signal to noise ratio SNR is related to the number of magnetic grains N in a recording bit by

$$SNR = 10 \log_{10} N \qquad (1)$$

In earlier studies we have found that a metallurgical grain can act as a magnetic grain when grains are magnetically decoupled by a non-magnetic phase [1,2]. Alternatively, several metallurgical grains can be exchange-coupled together when they are small [3]. An ideal morphology is one in which the non-magnetic atoms are segregated at the grain boundaries forming the non-magnetic phase while keeping the grains closely packed.

In this work we have used electron energy loss spectrometry to map the magnetic elements and non-magnetic elements. The Pr-Co nanostructured powders were prepared by mechanically milling $Pr_{20}Co_{80}$, followed by annealing at 800°C for 1 min. The x-ray diffraction pattern (XRD) indicates a single phase $PrCo_5$ with the $CaCu_5$ type structure. The magnetic properties were measured at 295 K using a SQUID magnetometer. Intrinsic coercivity (H_{ci}) of 17.5 kOe, remanent magnetization (M_r) of 51.8 emu/g, saturation magnetization (M_s) of 74.6 emu/g, and remanence ratio of 0.69 have been obtained from the powder. The remanence ratio higher than 0.5 is attributed to the weak exchange-coupling interaction between the nano-sized $PrCo_5$ grains in comparison with strong exchange-coupling with higher remanence ratio required in a permanent magnetic material [4]. We found Pr, a rare earth metal, segregate to grain boundaries in Co-Pr powder. Figure 1 shows an EELS map of Pr and Co. A Pr rich layer is clearly seen at the grain boundaries. This observation implies that Pr can be used as a non-magnetic phase in recording media. Thin films of Co-Pr system have been found to have a coercivity of 2-8 kOe [5], confirming its potential as a recording medium.

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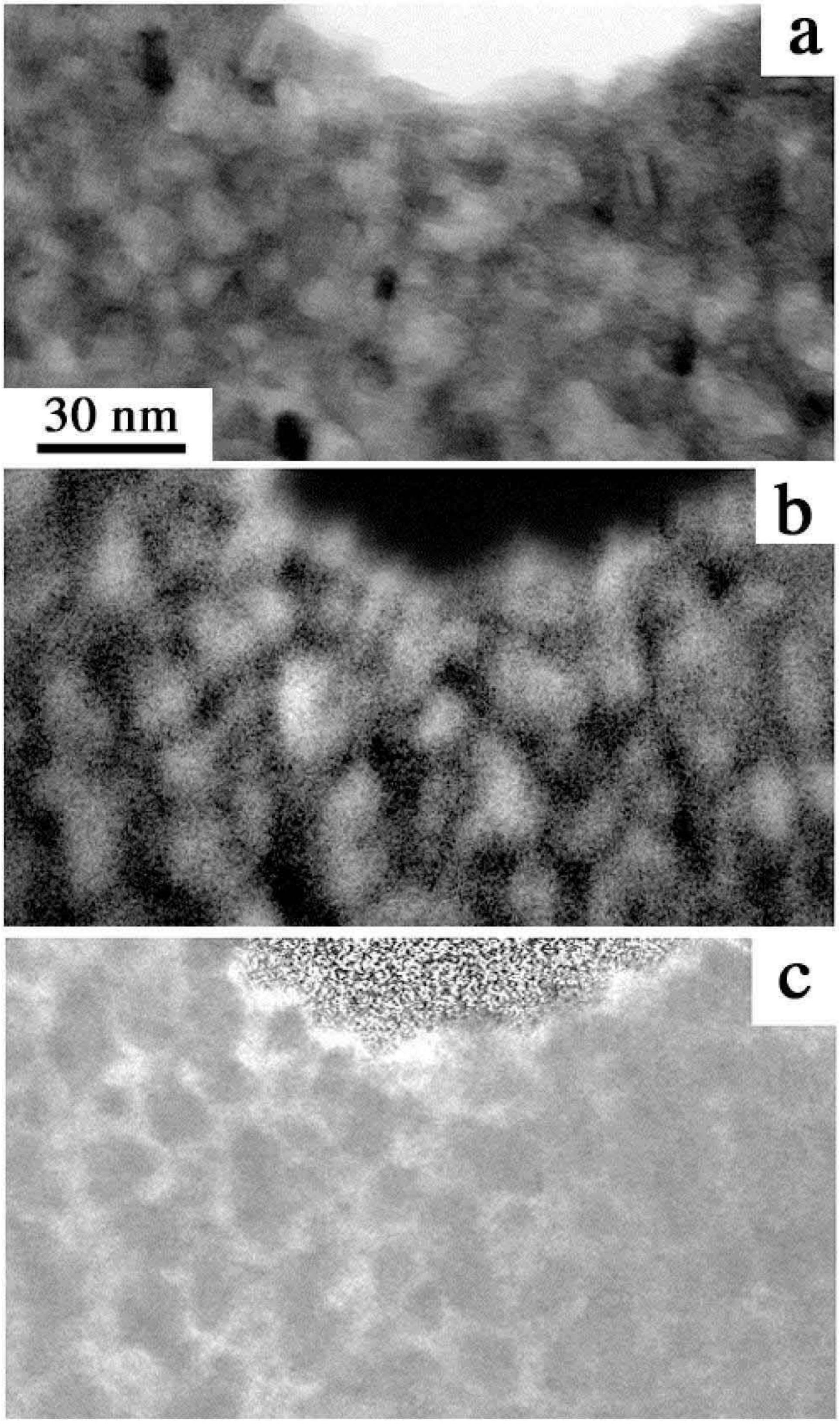

Figure 1. (a) bright field image, (b) Co map and (c) Pr map.