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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

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

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  $\text{Pr}_{20}\text{Co}_{80}$ , followed by annealing at  $800^\circ\text{C}$  for 1 min. The x-ray diffraction pattern (XRD) indicates a single phase  $\text{PrCo}_5$  with the  $\text{CaCu}_5$  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  $\text{PrCo}_5$  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.

### References

- [1] M. Yu, Y. Liu, and D. J. Sellmyer, J. Appl. Phys., Vol. 85, (1999) 4319.
- [2] C.P. Luo, S.H. Liou, L. Gao, Y. Liu, D.J. Sellmyer, Appl. Phys. Let. Vol. 77, (2000) 2225.
- [3] Y. Liu, Z. S. Shan, and D. J. Sellmyer, IEEE Trans. on Magn., Vol. 32, (1996) 3614.
- [4] Y. Liu, P. Liu and D.J. Sellmyer, Nanostructured materials, Vol. 12, (1999) 1027.
- [5] S.S. Malhotra, Y. Liu, Z.S. Shan, S.H. Liou D.C. Stanford and D.J. Sellmyer, J. of Mag. Mag. Mater. Vol. 161, (1996) 316.
- [6] YL acknowledges the visiting scientist award from NCEM and constructive discussions by Prof. U. Dahmen. This research is supported by CMRA and NSF grant 0076504.

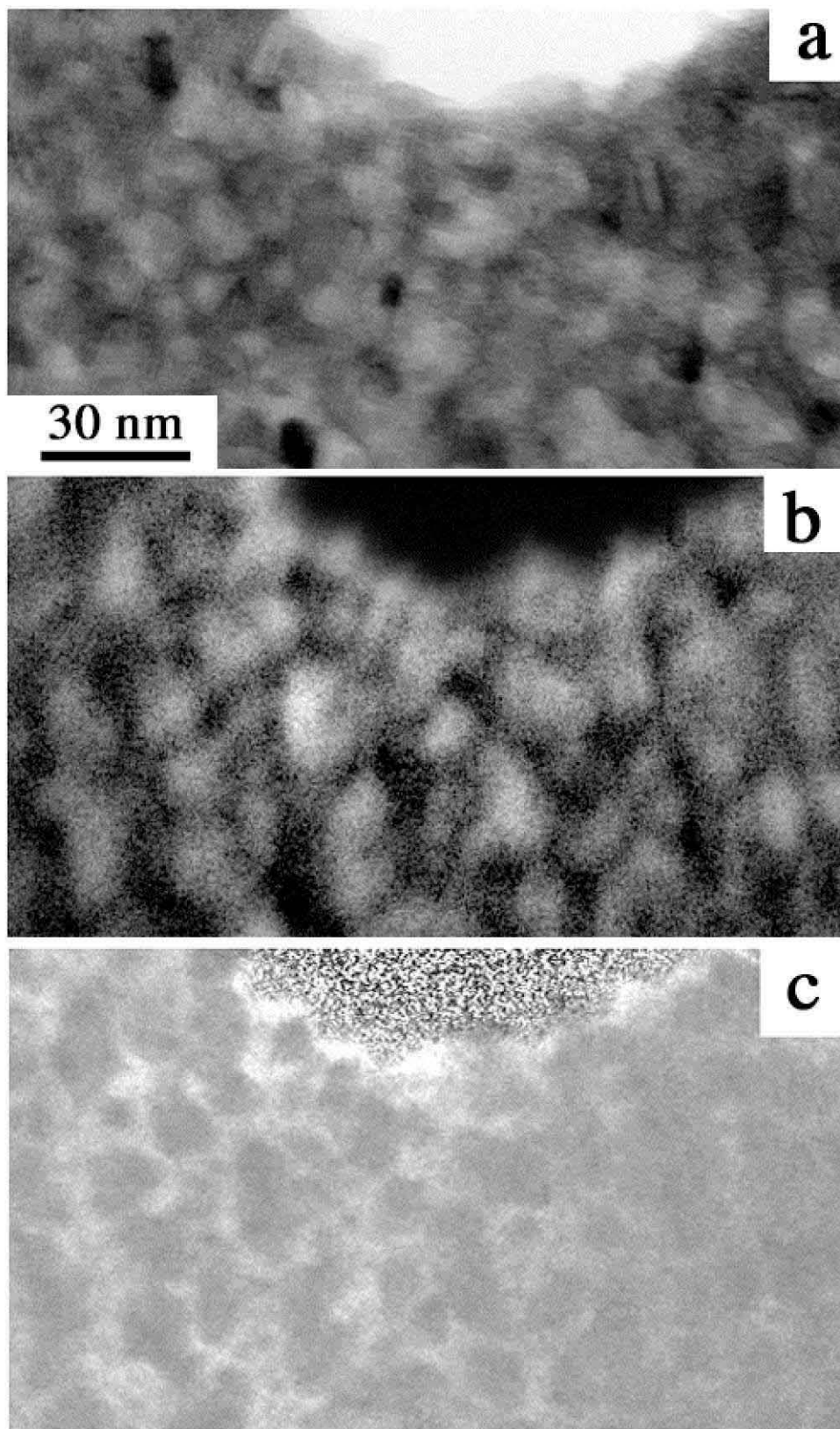


Figure 1. (a) bright field image, (b) Co map and (c) Pr map.