REVERSAL BEHAVIOUR IN PERPENDICULAR IRON PARTICLE ARRAY (ALUMITE MEDIA)

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High density recording media with a columnar morphology and a perpendicular orientation of the magnetization are very frequently mentioned in the literature. Up to now the reversal mechanism has not always been completely understood and depends, of course, on the dimensions of the columns and their manner of interaction. For instance the columnar morphology of sputtered CoCr films can lead to reversal based on domain wall motion if there is an exchange coupling between the columns. By complete magnetical isolation of the columns the magnetization will be rotated by one of the rotational reversal mechanisms. In this case the magnetostatic interaction plays an important role. The stray fields of a surrounding column will cause a difference between the applied field and the actual field at the site of the column. It is very difficult to quantitatively determine the columnar separation in sputtered CoCr. Therefore we have chosen Alumite media to investigate the influence of

no.	Cell size (nm)	Pore size (nm)	Thickness (nm)	P	M_s (kA/m)	H_{c1} (kA/m)	Sample
1	113	58	800	0.30	303	41	FDT45
2	91	36	3500	0.14	184	110	FDT410
3	62	30	3300	0.21	166	125	FDT45

deposited Fe needles are situated in an Al_2O_3 matrix. We have studied 15 hard- and soft-disk configurations with pore sizes (needle diameter) from 300-700nm

FIG.1 Perpendicular coercivity as a function of the packing density for two different cell sizes.

the particle interaction on the magnetic behaviour of a perpendicular anisotropic particle array. In the samples used electro- (needle diameter) from 300-700nm and cell sizes (distance between the needles) from 60-120nm [1]. The thicknesses varied from 700-4700nm. The packing density P is defined as the ratio of the volume of the magnetic Fe to the whole volume. In our sample, P varies from 0.13-0.43. Table 1 gives relevant information of 3 representative samples. If the applied field is parallel to the longer axis of the Fe cylinder, the nucleation field for the curling mode is given by [2] and is inversely proportional to r^2 (r =radius of the cylinder). In [3] we have shown that for Alumite the coercivity has a linear relation with r^2 , if the applied field

is large enough to saturate the sample. In Fig. 1 it is shown that the coercivity decreases with increasing volume packing fraction and follows:

$$H_c(P) = \alpha H_c(0) \cdot (1-P) \quad (1)$$

Here α depends on the size of the needles and their magnetization. Another deviation from curling is the angular dependence of the coercivity. The larger the angle θ (between applied field and sample normal) the larger the deviation from curling. We found that the reversal in Alumite can be interpreted from the superposition of the Cos type of the incoherent rotation and a switch of the magnetization by demagnetizing field and dipole-dipole field. The angular dependence of the reduced coercivity can be calculated by:

$$H_c(\theta)/H_c(0) = \alpha \cdot \cos\theta + (1-\alpha) \sin^2\theta. \quad (2)$$

Here $(1-\alpha)\sin^2\theta$ depends on the macroscopic demagnetizing field and the dipole-dipole field. In Fig. 2 the measured and calculated values are given for high- and low-coercivity Alumite samples and it can be seen that they are in good agreement.

FIG.2 The measured and calculated H_c/H_{c1} vs. θ for low and high coercivity samples.

References

- [1] The samples were supplied by Dr. Wakui from Yamaha Ltd., Japan.
- [2] A. Aharoni, Phys. Stat. Sol. 16,3 (1966).
- [3] G.T.A. Huysmans, J.C. Lodder and J. Wakui, J. Appl. Phys., 64 (4), 2016 (1988).