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Patterned media Made by Nanoimprint Lithography with a Self-assembled Polymer Mask

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Patterned media is a promising candidate for a high-density magnetic recording media. A magnetic layer of the recording media is cut into an array of tiny dots having a size of one bit (or one reversal unit). For successful commercialization of patterned media, two problems should be solved. Realization of a low-cost fabrication process with precise patterning is one of the serious problems. To keep the fly height less than 10 nm is another challenge. As a solution to the fabrication problem, we have proposed a new method of a nanoimprinting lithography with a self-assembled polymer mask [1]. Read and write test with a flying head was possible for this media.

Flying height of less than 10nm will be necessary for the high-density patterned media. We tried to use a liquid phase filling material (Spin-on Glass: SOG) for our patterned media [2]. SOG was first spin-coated on the patterned layer and then etched back by an ion milling process to the level just below the dot height. Figure 1 shows a magnetic force microscopy (MFM) image of the patterned media written by a flying ring head (nominal fly-height: 20 nm). The magnetization switching of each dot by the ring head is clearly shown.

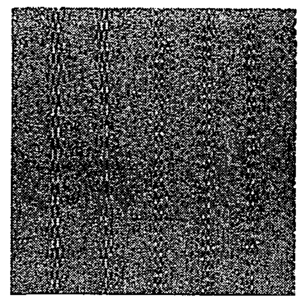

Fig. 1. MFM image of patterned media written by ring head.

Microscopic distribution of the magnetic characteristics should be considered for the patterned media. In the patterned media, large deviation in the magnetic characteristics of grains is expected since each patterned dot (bit) contains fewer grains. We measured the switching field distribution of the self-assembled patterned media by dot-by-dot MFM analysis [2]. Figure 2 shows the resulting coercivity (Hc) distribution. Large deviation in the Hc from 1.0 to 6.0 kOe was observed. One of the major causes of this result is a poor crystal orientation of each grain (one dot consists of 3-5 grains). However, similar large distribution of Hc is reported even for the conventional granular media. Precise investigation of the magnetic characteristics distribution will be necessary for the improvement of the patterned media.

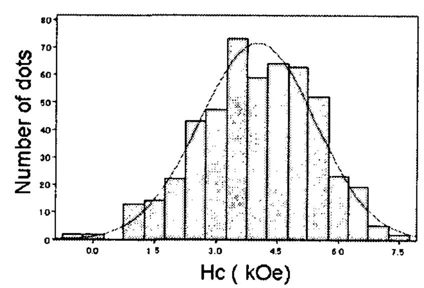

Fig. 2. Coercivity distributionof patterned dots.

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Structure and Magnetic Entropy Change in Melt-spun MnFePGe

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Magnetic refrigeration based on the magnetocaloric effect (MCE) has attracted much attention because of its numerous potential advantages over vapour-compression refrigeration[1-3]. MnFePAs (Ge) compounds have been identified as a promising alloy system to be used for magnetic refrigeration and the substitution of Ge for As has a strong effect on T_c and $|\Delta S|$[2,4]. In these works, the compounds have been synthesized by mechanical alloying (ball milling + solid-state reaction). Recently, we demonstrated that melt-spinning could be used to produce $La(Fe_{1-x}Si_x)_{13}$MCE materials by a much shortened annealing programme[5-6]. In the present work, $Mn_{1.1}Fe_{0.9}P_{0.76}Ge_{0.24}$ is prepared by melt-spinning and subsequent annealing (1000°C/1h), and structure and magnetic entropy changes are investigated. The annealed sample is single phase with the hexagonal Fe_2P-type structure. S-shaped magnetization curves with hysteresisare observed in the vicinity of the magnetic ordering temperature, resulting from a magnetic field-induced first-order phase transition. Due to this transition and a more homogenous element distribution resulting from the very high cooling rate during melt-spinning, the $Mn_{1.1}Fe_{0.9}P_{0.76}Ge_{0.24}$ compound shows a giant magnetocaloric effect. The maximum magnetic entropy change $|\Delta S|$ reaches 35.4 J/kg K in a field change from 0 to 5 T at around 317 K. This value is superior to that reported in the $Mn_{1.1}Fe_{0.9}P_{0.76}Ge_{0.24}$ compound synthesized by mechanical alloying (~30 J/kg K at 306 K)[7]. The excellent MCE properties, the low materials cost and the accelerated aging regime make the melt-spun-type MnFePGe materials an excellent candidate for magnetic refrigerant applications.

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