# High Resolution TEM study of exchange coupled FePt/CoPt thin films

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$L1_0$ ordered FePt has been proposed to be a promising candidate for high density recording materials due to its large magnetocrystalline anisotropy $K_u$, to keep thermal stability in smaller grains for higher recording density. On the other hand, an exchange coupled stacked structures, such as exchange coupled composite (ECC) media and exchange spring media are also have been studied lively to reduce the coercivity which is limited by the conventional recording head field [1,2]. In the exchange coupled media, relatively soft magnetic layer is deposited on the FePt layer. Ideally the soft layer is supposed to nucleate a magnetic domain under the smaller field than single hard layer, without deterioration of the magnetic properties of the hard layer. However, in reality, the elements in each layer diffuse into another layer that results unintended magnetic materials [3]. The diffusion leads even in very thin soft magnet(< 3 nm) to reduce coercivity much more than expected from the exchange spring effect [4]. In this study, we have studied the chemical composition changes in FePt/CoPt thin films with high resolution (HR) transmission electron microscopy.

The exchange coupled films structured of Si (100)/ SiOx/ FePt (20 nm)/ CoPt (40 nm) are prepared by sputtering. The sputtering of the FePt and CoPt are done in the same run, therefore there was no exposure to the air during the bilayer deposition. The films are annealed at 400 °C for 9 minutes. It is enough to initiate the transformation of FePt from disordered fcc to ordered fct structure, but too low for the CoPt transformation. Therefore it is expected that the bilayer structure is composed of FePt $L1_0$ and CoPt disordered fcc structures. The plane view images of the TEM study are shown in Fig.1. As seen in Fig.1a, the FePt grains (dark grains) and CoPt grains (bright lattice fringes) are overlapped and misaligned. In order to figure out the amorphous grain boundary materials in the CoPt layer, an energy dispersive spectroscopy (EDS) analysis was performed in the STEM mode. Fig.2 shows the STEM bright field image and the EDS line scans from A to A'. Since the grains are overlapped partially, an agglomerated intergranular phase is investigated instead of the grain boundary between the grains. The remarkable composition difference in the intergranular phase is the composition of platinum and oxygen. Compared to the granular phase, much less platinum and much more oxygen are contained in the intergranular phase, while the compositions of cobalt, iron and silicon are varied according to that of the each grain. The source of the silicon and oxygen is its substrate under the 20 nm FePt layer. From the cross sectional TEM study, it is shown that the diffusion of the elements was through all over the specimen, induced an amorphous phase between the FePt and CoPt layer. The diffusion is obviously been supported by the enhanced diffusion coefficient of Fe by factor of 2, near 400 °C [5]. Consequently the origin of the reduction of the coercivity with a very thin (<3 nm) CoPt layer is found to be the diffusion of elements.

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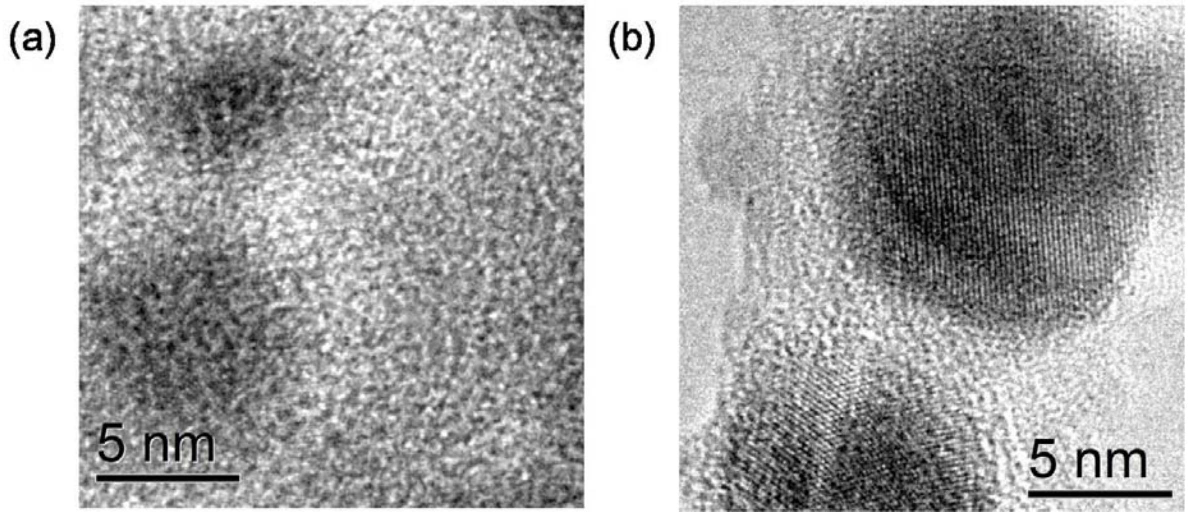


**Figure 1.** High resolution TEM images of (a) full thickness film and (b) FePt gains.

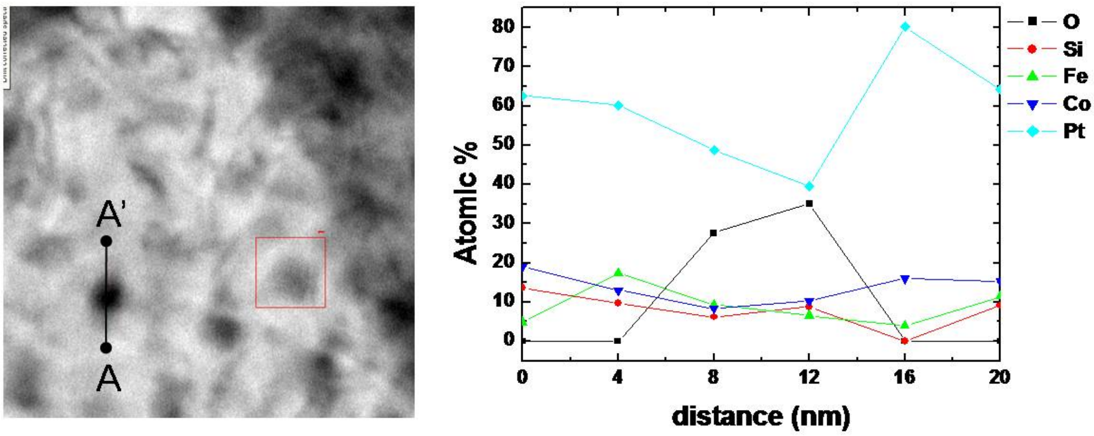


**Figure 2.** STEM BF image of the plane view of FePt/ CoPt thin film and a line scan EDS of AA'.


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