초청강연 1

Recent Development in Spin-Valve Read Heads for over 100 Gb/in^2 Magnetic Recording

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Quite dramatic is the evolution of a spin-valve read head over the past 10 years. Fig. 1 shows how the structure of the spin valve has changed as an areal density in magnetic recording increases rapidly. The early spin valve was mostly composed of a metallic cap and showed a GMR of 2-6%. Replacing the pinned layer with a synthetic antiferromagnet (SAF) decreased the GMR value little bit but enhanced head performance very much. The GMR values were 5-8%. Recently, enhancement in the specularity of electrons at the interfaces has become the most important issue to improve the MR performance. A spin valve with an oxide cap and an oxide antiferromagnet such as, NiO or Fe_2O_3 has shown a GMR value over 15% due to enhanced specular scattering [i]. However, the spin valve is less attractive for device applications because it has suffered from thermal instability, hard magnetism and small exchange bias. The recent proposal of a spin valve composed of thin oxide layers and a metallic antiferromagnet such as, PdPtMn or NiMn, is more practical and promising due to strong thermal stability, large exchange bias and good MR response as well [2][3]. In particular, a spin valve with oxides in pinned and capping layers (a so-called double specular spin valve) has promised to become the next generation read head due to improved MR performance.

Our specular spin valve fabricated by a novel technique has provided excellent head performance suitable for an ultra-high recording density. We previously used a spin valve with an oxide capping layer (a so-called single specular spin valve) for the demonstration of 56.1 Gb/in^2 [3]. The single specular spin valve (Fig.1(c)) was magnetically soft and its GMR value reached over 12%. However, the specularity was still low at the interface between the pinned layer and the Cu spacer. Embedding another oxide layer into the pinned layer (Fig. 1(d)), we enhanced the specularity and this led to a

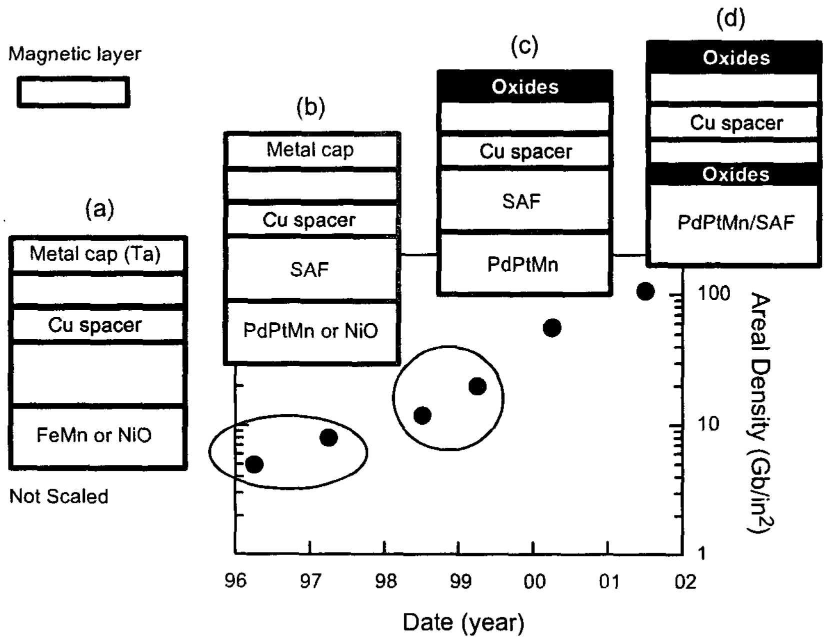

Fig. 1. The evolution of a spin-valve head with an areal density of magnetic recording.

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GMR value over 15%. As a matter of fact, we increased the output of the read head with this double specular spin valve by more than 50% over that of the read head used in the demonstration. As a result, we could demonstrate that the head with the double specular spin valve can be used for an areal density of over 100 Gb/in ^{2} in magnetic recording, with the help of advanced media and integration techniques [4]. It is clear that the ever-increasing areal density of disk drives will require GMR values higher than ever before for the next generation head. The next generation spin valve for far beyond 100 Gb/in^2 in magnetic recording will require a GMR value of ~15% or greater. Recently, our continuing engineering of the spin valve made it possible to obtain a GMR value of 20% using the double specular spin valve [5]. The GMR is the largest value ever reported for a spin valve with a single Cu spacer, irrespective of a kind of an antiferromagnet. Further enhanced specularity at the interface between the free and the capping layer contributed to the very high GMR. In addition, the spin valve showed a very large exchange bias field of over 1000 Oe and soft magnetic properties, which is essential to obtain high head output. The increase in GMR is likely from enhancement in the specularity. In this presentation, we review the evolution of a spin-valve film and a head and discuss other important issues for various spin valves.

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