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D E C I S I O N
of 18 November 2003

Case Number: T 0281/01 - 3.5.2

Application Number: 91310132.5

Publication Number: 0485129

IPC: H01F 10/08

Language of the proceedings: EN

Title of invention:
Method of making a GMR device

Patentee:
KABUSHIKI KAISHA TOSHIBA

Opponent:
Siemens AG Zentralabteilung Technik ZT PA Z

Headword:
-

Relevant legal provisions:
EPC Art. 54(2) and (3), 56, 83, 123(2)

Keyword:
"Admissibility of amendments (yes)"
"Sufficiency of disclosure (yes)"
"Novelty and inventive step (yes)"

Decisions cited:
G 0009/91, G 0009/92, G 0001/99

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0281/01 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 18 November 2003

Appellant: (Opponent)
Siemens AG
Zentralabteilung Technik ZT PA Z
Postfach 22 16 34
D-80506 München (DE)

Representative:
-

Respondent: (Proprietor of the patent)
KABUSHIKI KAISHA TOSHIBA
72, Horikawa-cho,
Saiwai-ku
Kawasaki-shi,
Kanagawa-ken 210-8572 (JP)

Representative:
Freed, Arthur Woolf
MARKS & CLERK
57-60 Lincoln's Inn Fields
London WC2A 3LS (GB)

Decision under appeal:
Interlocutory decision of the Opposition Division of the European Patent Office posted 9 January 2001 concerning maintenance of European patent No. 0485129 in amended form.

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: J.-M. Cannard
P. Mühlens

Summary of Facts and Submissions

I. The opponent appealed against the decision of the opposition division concerning the maintenance of European patent No. 0 485 129 in amended form in accordance with the proprietor's main request filed on 16 November 2000 during oral proceedings before the opposition division.

II. Prior art documents:

D5: IEEE Transactions on Magnetics, vol. 25, no. 5, September 1989, pages 4278 to 4282,

considered during the proceedings before the opposition division,

D16: US-A-4 949 039,

filed for the first time in the appellant's statement of grounds of appeal, and:

D17: EP-A-0 490 608,

filed for the first time in the appellant's letter dated 13 October 2003,

are considered in the present decision.

III. Claim 1 filed on 18 November 2003 during oral proceedings before the Board of appeal reads as follows:

"A method of manufacturing a giant magneto-resistance device, comprising the steps of:

forming a multi-layer of ferromagnetic and non magnetic laminated layers on a substrate, such that a non magnetic layer is interposed between the ferromagnetic layers, the thickness of said ferromagnetic layers is from 0.5 to 20nm;

introducing uniaxial magnetic anisotropy into said ferromagnetic layers in predetermined directions, characterised in that the multilayer is formed on a non-single crystalline substrate and, in that the uniaxial magnetic anisotropies are introduced into two ferromagnetic layers adjacent to a non-magnetic layer, by applying a magnetic field along the surface of said ferromagnetic layers while heat treating after the formation of said multilayer, wherein the angle formed between the directions of uniaxial magnetic anisotropies to be introduced to the two ferromagnetic layers adjacent a non-magnetic layer is from 30° to 90° and wherein one of the two ferromagnetic layers adjacent a non-magnetic layer consists of a soft magnetic layer and the other of said two adjacent ferromagnetic layers consists of a hard magnetic layer."

Claims 2 to 4 are dependent on claim 1.

IV. The arguments of the appellant opponent can be summarised as follows:

Article 123(2) EPC

The only support for a method of manufacturing a giant magneto-resistance device in which an angle of 30° to

90° was introduced between the uniaxial magnetic anisotropies of a soft and a hard ferromagnetic layer by applying a magnetic field along the surface of these layers was to be found in examples 7 and 8 described in the originally filed application. According to these examples, said angle was introduced during the formation of the multilayer, not after its formation as presently claimed. The various features recited in claim 1 which were concerned with the introduction of this angle were specified as parts of separate embodiments in the set of claims originally filed. There was no support in the application as originally filed for the combination of features recited in claim 1.

Article 83 and 100(b) EPC

There was no sufficient disclosure in the patent application to enable the skilled man to carry out a method for introducing an angle from 30° to 90° between the uniaxial magnetic anisotropies of a soft magnetic layer and a hard magnetic layer while heat treating after the formation of the multilayer. In any case, the general statements on pages 3 and 4 of the application and examples 7 and 8 which were concerned with the introduction of this angle did not specify any required conditions for the magnetic filed, or the temperature. It was not proved that at the priority date of the patent such a method formed part of the common knowledge of the skilled man.

Article 54, 56 and 100(a) EPC

Document D17 which formed part of the prior art under Article 54(3) EPC destroyed the novelty of the method according to claim 1. In the embodiment of figure 4, the magnetic field, which was applied to a layer (18) while heat treating after the formation of the multilayer, necessarily introduced uniaxial magnetic anisotropies in both ferromagnetic layers after their formation, as in claim 1.

Document D16 disclosed a method of manufacturing a giant magneto-resistance device which differed from the method of claim 1 only in that the uniaxial magnetic anisotropies of the two ferromagnetic layers were aligned antiparallel. D16 was concerned with the problem of magnetically decoupling the two ferromagnetic layers. D5, which disclosed a device similar to that of D16 and was concerned with the same problem, solved it by orienting the anisotropies of the two ferromagnetic layers perpendicular to each other. The skilled man would apply the solution known from D5 in the method of D16 and arrive thereby at the method according to claim 1, without exercising an inventive step.

V. The arguments of the respondent proprietor can be summarised as follows:

Article 123(2) EPC

Claim 1 filed in the oral proceedings was based on the method according to the second embodiment recited in the combination of claims 1 and 5 which were maintained

by the opposition division, namely a method of manufacturing a giant magneto-resistance device in which uniaxial magnetic anisotropies were introduced to the two ferromagnetic layers by applying a magnetic field along the surface of said layers while heat treating after the formation of the multilayer, and was restricted to the case where one of the ferromagnetic layers adjacent a non-magnetic layer was a soft magnetic layer and the other a hard magnetic layer. Such features were disclosed in the originally filed application, in particular the introduction of the angle between the uniaxial magnetic anisotropies after the formation of the multilayer was disclosed as a general statement applying to all the embodiments of the invention (see published application, page 3, lines 34 to 38 and example 7, page 7, lines 22 to 27).

Articles 83 and 100(b) EPC

The opponent did not object during the opposition proceedings that the introduction of an angle from 30° to 90° between the uniaxial magnetic anisotropies of a soft magnetic layer and a hard magnetic layer while heat treating after the formation of the multilayer was insufficiently disclosed in the patent application. It was part of the common knowledge of the skilled person at the priority date of the patent that the uniaxial magnetic anisotropies of soft and hard magnetic layers of a multilayer could be oriented in sequence by applying appropriate magnetic fields and temperatures after the formation of the multilayer.

Articles 54, 56 and 100(a) EPC

D17, which did not disclose a soft ferromagnetic layer whose uniaxial anisotropy was introduced after the formation of the multilayer, did not destroy the novelty of the method according to claim 1.

Starting from D16, which related to a giant magneto-resistance device, the objective problem was to control the magneto-resistance value. D5 did not disclose a giant magneto-resistance device and according to its title was concerned with a totally different problem, namely the reduction of the effects of uniaxial anisotropy. There was no obvious reason for the skilled man to combine the teachings of D16 and D5.

VI. The appellant requested that the decision under appeal be set aside and the patent be revoked.

VII. The respondent requested that the patent be maintained in amended form in the following version:

Claims: 1 to 4 filed in the oral proceedings,

Description: pages 2 to 8 filed in the oral proceedings,

Drawings of the patent specification.

Reasons for the Decision

1. The appeal is admissible.

2. *Admissibility of the amendments in claim 1*

The Board is satisfied that present claim 1 satisfies the requirements of Article 84 EPC and does not contravene Article 123(2) or (3) EPC. More specifically:

2.1 A method of manufacturing an artificial multilayer comprising the steps of:

forming a multilayer of ferromagnetic and non magnetic laminated layers, such that a non magnetic layer is interposed between the ferromagnetic layers, and

introducing uniaxial magnetic anisotropies into the two ferromagnetic layers adjacent to a non-magnetic layer by applying a magnetic field along the surface of said ferromagnetic layers, so that the angle formed between the directions of uniaxial magnetic anisotropies to be introduced to the two ferromagnetic layers is from 30° to 90°,

is disclosed in the combination of claims 15, 23 and 24 of the application as originally filed.

2.2 A restriction of this originally claimed method to a method, wherein one of the two ferromagnetic layers adjacent a non-magnetic layer consists of a soft magnetic layer and the other of said two adjacent ferromagnetic layers consists of a hard magnetic layer, is supported by the embodiment of figure 8B and by the

second one of the two methods for introducing a unixial anisotropy to a multilayer utilizing both a soft layer and a hard layer described in the application as filed (see the published application, page 4, lines 10 and 11 and 18 to 23; page 7, lines 22 to 27).

2.3 The Board is of the opinion that the features of the giant magneto-resistance device, and the method for manufacturing it, presented in the description of the application as filed (see page 3, lines 25 to 44) as features of "the present invention", and more specifically the formation of the multilayer on a non-single crystalline substrate, the introduction of uniaxial magnetic anisotropies into the ferromagnetic layers by applying a magnetic field while heat treating after the formation of said multilayer, and a thickness of said ferromagnetic layers is from 0.5 to 20nm, which are recited in originally filed claims 25, 17 and 22 as separate embodiments of the method, correspond to general features of said "invention" which can be comprised in all the embodiments of realisation disclosed in said application.

2.4 Accordingly, the Board judges that a method for manufacturing a giant magneto-resistance device according to present claim 1, which comprises in combination the features recited in original claims 15, 23 and 24, the general features "of the present invention" referred to previously and wherein one of the two ferromagnetic layers adjacent a non-magnetic layer consists of a soft magnetic layer and the other of said two adjacent ferromagnetic layers consists of a hard magnetic layer, does not extend beyond the content of the application as originally filed.

2.5 The feature "wherein the layers of the device are configured such that the electrical resistivity of the ferromagnetic layers is a maximum when the magnetizations of said two ferromagnetic layers adjacent a non magnetic layer are aligned antiparallel to one another and a minimum when aligned parallel with one another", which was introduced in claim 1 maintained by the opposition division in contravention of Article 123(2) EPC, has been deleted. The deletion of this feature from present claim 1, which widens the scope of the claim and puts the opponent, who is the sole appellant, in a situation worse than if he had not appealed, appears at first sight to offend against the prohibition of *reformatio in peius* (G 9/92, OJ 1994, 875). However, an exception to this principle may be made in circumstances, as in the present case, where the patent as maintained in amended form would otherwise have to be revoked as a consequence of an inadmissible amendment held allowable by the opposition division in its interlocutory decision (G 1/99, OJ 2001, 381).

3. *Sufficiency of disclosure*

3.1 During the oral proceedings before the Board of appeal, the opponent argued that the patent application does not disclose the method of the invention in a manner sufficiently clear and complete for it to be carried out by the skilled person throughout the scope of claim 1, in particular the step according to which "uniaxial magnetic anisotropies are introduced into two ferromagnetic layers (consisting a soft magnetic layer and a hard magnetic layer) adjacent to a non magnetic

layer by applying a magnetic surface along the surface of said ferromagnetic layers while heat treating after the formation of the multilayer".

3.2 The invention according to present claim 1 is covered by the second embodiment of the invention recited in claims 1, 4 and 5 of the patent as granted, or claims 1, 4 and 5 of the patent as maintained, taken in combination, namely the embodiment in which the uniaxial anisotropies are formed in the ferromagnetic layers after the formation of the multilayer. The late raising of the objection under Article 83 EPC cannot thus be justified by a change in the scope of the claimed invention. The two ferromagnetic layers consisting of two types of materials recited in the claims are described in the description of the patent application as filed as being a hard and a soft magnetic layer (see published application, page 3, line 50; page 4, lines 10 to 23). This is not disputed by the opponent, in whose letter of 13 October 2003, page 2, the two different types of ferromagnetic layers are identified as a hard and a soft magnetic layer.

3.3 In the statement of grounds of opposition, the opponent argued that a method of manufacturing a magneto-resistance device, when (a) the ferromagnetic layers consist of one type of material, (b) an angle from 30° to 90° is formed between the directions of uniaxial magnetic anisotropies introduced to the two adjacent ferromagnetic layers, and (c) the uniaxial magnetic anisotropies are introduced to these layers during heat treating after the formation of the multilayer, was not disclosed in a sufficiently clear and complete method in the patent application. However, an objection

relating to an insufficient disclosure in the application of a method of manufacturing a magneto-resistance device in which said angle from 30° to 90° is introduced between a soft magnetic layer and a hard magnetic layer while heat treating after the formation of the multilayer (thus a method corresponding to that of the invention recited in present claim 1) was not raised during the opposition proceedings by the opponent.

3.4 Forming an angle between the directions of uniaxial magnetic anisotropies of the two ferromagnetic layers during heat treating after the formation of the multilayer when these layers consist of a soft and a hard magnetic layer implies measures which are totally different from those involved in forming such an angle when the ferromagnetic layers consist of one and the same type of material. Therefore, the objection put forward for the first time during the oral proceedings before the Board of appeal, according to which a method as recited in present claim 1 is not sufficiently disclosed in the patent application, constitutes a fresh ground for opposition, which being outside "the legal and factual framework" of the opposition, cannot be considered in the appeal proceedings without the approval of the patentee (see decisions of the Enlarged Board of Appeal G 9/91 and G 10/91, OJ 1993, 408 and 420, especially points 6 and 18 of the reasons). Since it is clear from the patentee's statements made during the oral proceedings of 18 November 2003 that such an approval has not been given, the objection cannot be taken into consideration.

4. *Document D17*

4.1 Document D17 was cited by the appellant in reaction to the submission by the proprietor of a new claim 1 in reply to the statement of grounds of appeal. D17 was published after the date of filing of the opposed patent. It is common ground that claim 1 is not entitled to the first priority date (1 November 1990) claimed by the opposed patent. Under these circumstances, the appellant argued that D17 formed part of the state of the art under Article 54(3) EPC because its priority date (11 December 1990) is earlier than that of the second priority date (27 March 1991) of the opposed patent.

4.2 D17 (figures 3 to 5; column 3, line 55 to column 5, line 15) discloses a multilayer magneto-resistance device in which a first layer of a soft magnetic material (12), a layer of a non magnetic material (14) and a second layer of a magnetic material (16) having a higher coercivety than that of the first layer are deposited on a glass substrate (10), the two layers of ferromagnetic material being oriented so that their magnetization are at an angle of about 90 degrees.

4.3 However, the method according to claim 1 is novel with respect to D17 which does not disclose the introduction of uniaxial magnetic anisotropies into the soft and hard magnetic layers after the formation of the multilayer. According to the embodiment of figure 3, the first (soft) ferromagnetic layer is deposited while applying a magnetic field to orient the easy axis of the soft layer (column 5, lines 49 to 53) and the uniaxial anisotropy of the one ferromagnetic layer thus

is introduced during the formation of the multilayer. According to the embodiment of figure 4, an antiferromagnetic layer is deposited after the deposition of the ferromagnetic layers 12 and 16. This layer is oriented while heat treating after its deposition by applying a magnetic field perpendicularly to the direction of the easy axis of the soft layer (12), thus after the orientation of the soft layer (column 6, lines 29 to 47). Thus the uniaxial magnetic anisotropy of one of the two ferromagnetic layers (the soft layer) is introduced before applying the field to the layer (18) and consequently it cannot be deduced that it is necessarily introduced after the formation of the multilayer. Under these circumstances, it can remain undecided whether D17 forms part of the state of the art under Article 54(3) EPC.

5. *Inventive step*

5.1 Document D16 was cited for the first time in the statement of grounds of appeal and being responsive to the reasons given in the decision under appeal can be considered in the proceedings. It is common ground that D16 forms the closest prior art under Article 54(2) EPC.

5.2 D16 discloses a multilayer magneto-resistance device formed by two ferromagnetic layers and a non-magnetic layer interposed between these ferromagnetic layers. In all embodiments of realisation, the magnetizations of the two ferromagnetic layers are aligned antiparallel (figures 2 to 4; column 3, line 40 to column 6, line 18). According to a first embodiment of realisation (column 3, lines 49 to 65), the two ferromagnetic layers have sufficiently different

coercive fields and the device may be considered as a giant magneto-resistance device in the sense of claim 1. The method of claim 1 thus differs from this first embodiment, which forms the closest prior art, in that it comprises a step of introducing an angle from 30° to 90° between the directions of uniaxial magnetic anisotropies of the two ferromagnetic layers adjacent the non-magnetic layer by applying a magnetic field along the surface of the ferromagnetic layers while heat treating after the formation of the multilayer.

6. Document D5 (see the abstract; page 4280, left column, lines 6 to 11; figure 3) discloses a magneto-resistance device comprising a structure formed of two identical ferromagnetic layers (NiFe) and a non ferromagnetic layer (Cr) disposed between the ferromagnetic layers. Perpendicular anisotropies may be introduced into the ferromagnetic layers during the formation of the layers.

7. According to the appellant, the skilled man starting from the prior art according to D16 would arrive at the method of claim 1 by replacing in an obvious way the two ferromagnetic layers with antiparallel alignment in this prior art by ferromagnetic layers having mutual perpendicular anisotropy as in D5. The Board cannot share the applicant's view.

7.1 An antiparallel alignment of the two ferromagnetic layers is an essential feature of all the embodiments of realisation disclosed in D16. In the first one, these two layers are chosen with sufficiently different coercive fields so that this alignment can be obtained by applying an external field (column 3, lines 54 to 59). In contrast with that, according to the

teaching of D5, mutually perpendicular anisotropies are introduced in two identical Permalloy layers for solving a systematic error in Permalloy thin film detectors. Starting from the first embodiment of D16, it is unlikely that the skilled man would consider orienting the ferromagnetic layers as in D5, which is concerned with another kind of device. This would entail replacing an essential feature (antiparallel alignment) of the ferromagnetic layers in the first embodiment of D16, independently of the materials of these layers which were selected to provide the essential feature.

7.2 In any case, it is clear that a straightforward replacement of the step for obtaining the antiparallel alignment of the ferromagnetic layers in the first embodiment of D16 by a method for obtaining perpendicular anisotropies of layers as in D5 would not, by itself, lead to uniaxial magnetic anisotropies introduced by applying a magnetic field to the ferromagnetic layers while heat treating after the formation of the multilayer.

7.3 Thus the combination of the prior art according to D16 with the teaching of D5 is not obvious and would not lead to the method of manufacturing set out in claim 1.

8. Accordingly, the arguments of the appellant have not convinced the Board that the subject-matter of present claim 1 was obvious to the person skilled in the art. The Board therefore concludes that the subject-matter of this claim shall be considered as involving an inventive step within the meaning of Article 56 EPC.

9. In the Board's judgement, the patent in suit and the invention to which it relates satisfy the requirements of the Convention.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to maintain the patent in amended form in the following version:

Claims: 1 to 4 filed in the oral proceedings,

Description: pages 2 to 8 filed in the oral proceedings,

Drawings of the patent specification.

The Registrar: The Chairman:

D. Sauter W. J. L. Wheeler