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Datasheet for the decision of 8 February 2018

Case Number: T 1343/13 - 3.4.03

Application Number: 05723406.4

Publication Number: 1716561

IPC: H01L43/00, G11B5/673

Language of the proceedings: EN

Title of invention:
SPIN TRANSFER MAGNETIC ELEMENT HAVING LOW SATURATION MAGNETIZATION FREE LAYERS

Applicant:
Samsung Semiconductor, Inc.

Headword:

Relevant legal provisions:
EPC 1973 Art. 54(1), 54(2)
RPBA Art. 15(3)

Keyword:
Oral proceedings - held in absence of appellant
Novelty - (no)

Decisions cited:

Catchword:

Europäisches Patentamt
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Office européen des brevets

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Case Number: T 1343/13 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 8 February 2018

Appellant: (Applicant)	Samsung Semiconductor, Inc. 3655 North First Street San Jose, CA 95134 (US)
Representative:	Brookes IP Windsor House 6-10 Mount Ephraim Road Tunbridge Wells Kent TN1 1EE (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 4 February 2013 refusing European patent application No. 05723406.4 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	G. Eliasson
Members:	M. Stenger
	W. Van der Eijk

Summary of Facts and Submissions

I. The appeal concerns the decision of the examining division to refuse European patent application no. 05723406 for lack of inventive step.

II. The following document will be referred to:
D12: US 5695864 A

III. The appellant requests the grant of a patent on the basis of claims 1 to 15 filed with letter dated 2 January 2018.

IV. With letter dated 22 January 2018, the appellant indicated that it would not be represented during oral proceedings.

V. Oral proceedings before the Board were held on 8 February 2018 in the absence of the appellant.

VI. Independent claim 1 of the only request has the following wording (labeling added by the Board):

A magnetic element comprising:
(a) a pinned layer (110);
(b) a spacer layer (120), the spacer layer being nonmagnetic; and
(c) a free layer (130) having a free layer magnetization, the spacer layer (120) residing between the pinned layer (110) and the free layer (130),
(d) the free layer (130) including at least one ferromagnetic material that is diluted with at least one nonmagnetic material and/or ferrimagnetically doped

(e) such that the free layer has a low saturation magnetization free layer of less than 1.43 x 10^6 A/m at room temperature;

wherein

(f) if the free layer (130) includes the at least one ferromagnetic material that is diluted with the at least one nonmagnetic material, then the free layer (130) includes at least CoX, FeX, NiFeX, CoXY, FeXY, CoFeXY, NiFeXY, and/or CoNiFeXY where X or Y is Cr, Cu, Au, B, Nb, Mo, Pt, Pd, Ta, Rh, Ru, Ag, TaN, CuN, TaCuN, and/or CoFeX where X is Cr, Cu, Au, Nb, Mo, Pt, Pd, Ta, Rh, Ru, Ag, TaN, CuN, and TaCuN, wherein X is at least five atomic percent and less than or equal to sixty atomic percent for Cr, Cu, Au, B, Nb, Mo, Ta, Rh, Ru, Ag, TaN, CuN, and/or TaCuN and at least five atomic percent and les than or equal to eighty atomic percent for Pt and Pd and Y is at least five atomic percent and less than or equal to sixty atomic percent for Cr, Cu, Au, B, Nb, Mo, Ta, Rh, Ru, Ag, TaN, CuN, and/or TaCuN and at least five atomic percent and less than or equal to eighty atomic percent for Pt and Pd,

(g) wherein the magnetic element is configured to allow the free layer magnetization to be switched due to spin transfer when a write current is passed through the magnetic element.

VII. The wording of independent claims 2 and 13 is not reproduced here since it is not relevant for the present decision.

VIII. The arguments of the appellant, as far as they are relevant for the present decision, may be summarised as follows (see second and third paragraphs of page 2 of the letter dated 2 January 2018):

(a) Document D12 did not disclose the stoichiometries for a free layer diluted by nonmagnetic materials as recited in claim 1.

(b) Further, concerning the doping with ferrimagnetic materials, the relevant portions of the specification stated that the combination of materials used was CoX, FeX, CoFeX and/or NiFeX, where X was the rare earth element Gd and/or Tb. Possible combinations for Gd were thus CoGd, FeGd, CoFeGd, NiFeGd and/or CoNiFeGd. This implied that for each of these combinations, the magnetic material content was 50 atomic percent while the Gd and/or Tb content also was 50 atomic percent. In contrast to that, D12 disclosed a concentration of the rare earth material of only 17 atomic percent and thereby a concentration of the ferromagnetic material of 83 atomic percent. The stoichiometry disclosed in D12 would thus not correspond to the stoichiometry required by the application.

Reasons for the Decision

1. Procedural matters

The claims of the only request were submitted in response to the summons to oral proceedings before the Board. The duly summoned appellant was not represented at the oral proceedings. The proceedings were however continued without the appellant in accordance with Rule 71(2) EPC 1973, the Board relying on the appellant's written case according to Article 15(3) RPBA.

The Board had already raised the issue of lack of novelty with respect to claim 1 in the summons to oral

proceedings (section 4.1). The amendments of that claim as submitted in response to the summons were merely directed at overcoming clarity objections and did not address the issue of novelty.
Only arguments concerning novelty were filed. These arguments were not found convincing by the Board as detailed below.

2. Preliminary remark concerning claim 1
Due to the presence of the term *and/or* in feature (d) of claim 1 and as pointed out by the appellant in his letter dated 2 January 2018 (page 3, penultimate paragraph), the desired low saturation magnetization required by feature (e) can be obtained, according to feature (d) of claim 1, in three alternative ways:

(d1) nonmagnetic dilution of the free layer *only*,

(d2) ferrimagnetic doping of the free layer *only*, or

(d3) *both* nonmagnetic dilution and ferrimagnetic doping.

The Board notes that feature (f) is formulated such that it is required only in the presence of nonmagnetic dilution, i.e. only in combination with alternatives (d1) and (d3).

3. Document D12
Document D12 relates to magnetic components that comprise a multilayer structure containing two ferromagnetic layers F1 and F2 separated by a nonmagnetic layer B. The magnetization direction of layer F1 is fixed while the magnetization direction of layer F2 can be changed without applying an external magnetic field by means of spin transferred from the

electrons of a switching current (abstract and column 1, lines 25 to 52 and column 2, line 29 to column 3, line 34 in combination with figure 1).
D12 discloses a plurality of embodiments directed to different applications of the magnetic components. One of these embodiments relates to magnetic memory cells (as the main embodiment of the application, see page 4, lines 13 to 16). Its structure is shown in figure 6 (see also column 8, lines 26 to 32 of D12).

4. Claim 1, D12

In the terms of claim 1, D12 discloses:

A magnetic element (*memory cell*, see column 8, lines 26 to 32; see also abstract) comprising
(a) a pinned layer F1 (column 10, lines 52 to 56);
(b) a spacer layer B, the spacer layer being non-magnetic (column 10, lines 57 to 60; gold and copper are non-magnetic); and
(c) a free layer F2 having a free layer magnetization, said spacer layer B residing between the pinned layer F1 and the free layer F2,
(d2) the free layer F2 including at least one ferromagnetic material (Co) that is ferrimagnetically doped (by means of Gd, Tb or Dy; column 10, lines 61 to 63);
(g) wherein the magnetic element is configured to allow the free layer magnetization to be switched due to spin transfer when a write current is passed through the magnetic element (*reflection-mode spin transfer*, column 9, lines 9 to 30; see also abstract and column 1, lines 25 to 52).

Further, the saturation magnetization of (pure) Co is around 1.43×10^6 A/m at room temperature, as mentioned

in the application (page 9, lines 3 to 5). Thus, doping of Co with a ferrimagnetic material will, irrespective of the concentration of the ferrimagnetic material, inevitably result in a saturation magnetization lower than that value.
The layer F2 of figure 6 of D12 may consist of $GdCo_5$, i.e. of ferrimagnetically doped Co (column 10, lines 61 to 63), thus implying a saturation magnetization that is lower than 1.43×10^6 A/m at room temperature.
In that respect, the Board notes that the concentration of Gd in $GdCo_5$ is about 17 atomic percent and thus well within the range of 5 to 60 atomic percent required for the rare earth content in the portion of the specification of the application relating to the alternative of ferrimagnetic doping (page 12, lines 1 to 11).
Therefore, D12 implicitly discloses feature (e) as well.

The Board notes that feature (f) is not required in combination with the alternative (d2) as disclosed in D12.

Consequently, the subject-matter of claim 1 is not new according to Article 54(1) and (2) EPC 1973, since all of its features are already disclosed in D12 in relation with the embodiment shown in figure 6.

5. Arguments of the applicant

5.1 Dilution with nonmagnetic material (see VIII (a))
The Board accepts that D12 does not disclose the stoichiometries of feature (f) as argued by the appellant.

Feature (f) is, however, required only in combination with any of the alternatives (d1) and (d3), as mentioned above. Thus, this argument does not apply, since D12 discloses alternative (d2) instead.

5.2 Ferrimagnetic doping (see VIII (b))

Contrary to the argument of the appellant, the combinations of materials CoX, FeX etc. in lines 14 to 16 on page 12 of the application can not be interpreted as empirical or molecular formulae implying that the share of Co and Fe in atomic percent in these materials is *equal* to the share of X (and thus 50 atomic percent).

Instead, the letter X has to be seen as being only a place holder or dummy variable for a type of chemical element (*where X is the rare earth elements Gd and/or Tb*, page 12, line 16) without implying any restriction with respect to stoichiometry. This is consistent with the use of the letters X and Y in the parts of the application relating to the dilution with non-magnetic materials, where the stoichiometric content of the diluting chemical elements is explicitly defined in addition to their names, see, e.g., feature (f).

Thus, the stoichiometry of $GdCo_5$ disclosed in D12 corresponds to what is required by the description of the application for ferrimagnetic doping.

The Board notes that claim 1 per se does not define any specific concentration of the ferrimagnetic material at all.

6. The subject-matter of claim 1 of the only request is not new according to Article 54(1) and (2) EPC 1973. The request is thus not allowable.

It is therefore not necessary to discuss the other issues raised in the aforementioned communication by the Board.

7. Since the only request on file is not allowable, the appeal must fail.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated