Sujet : Lecture de mémoires magnétiques au niveau des cellules bits sans utiliser l'accès électrique conventionnel

Doctorante : DUMAS Louise

Laboratoire d'accueil

Responsable :
BASCOUL Guillaume

Co-financeur

Encadrant :
GUERIN Christophe

Directeurs de thèse :
MARC François
FREMONT Hélène

Encadrante :
VILLENEUVE-FAURE Christina

Contexte

Décryptage

Documentation en ligne

Methodology of backside preparation applied on a MRAM to lead a logical investigation with a near-field probe

Louise DUMAS [1,2,3,4,*], Christina VILLENEUVE-FAURE [4], François MARC [2], Hélène FREMONT [2], Christophe GUERIN [3], Guillaume BASCOUL [1]

[1] Laboratoire d'Expertise, Centre National d'Etudes Spatiales (CNES), Toulouse, France
[2] Laboratoire IMS, Université de Bordeaux, Talence, France
[3] Direction Générale de l'Armement Maîtrise de l'information (DGA MI), Rennes, France
[4] LAPLACE (Laboratoire Plasma et Conversion d'Energie), Université de Toulouse, CNRS, UPS, INPT, Toulouse, France

Abstract

This paper presents a method for the preparation of a magnetic random access memory (MRAM) whose data are stored in magnetic tunnel junctions (MTJ) as resistance states, in order to read them by near-field probing. The goal is to be able to visualize a difference of resistance between bits at '0' and at '1' thanks to the current passing through several MTJs. To do so, the MRAM needs to be prepared to create an electrical access to both sides of the MTJs. The main issue is the polishing of both sides as the stack of metallization being less than 10 µm thick. A chemical etch would in that case be encouraged by literature but we take a different approach since we choose to open further than the transistors. The preferred method is a backside preparation technique that creates a bevel allowing us to access the bottom side of the MTJs through vias and the top of them thanks to the bitlines. Since the resulting chip no longer has electrical connections, we also create a dedicated electrical path thanks to a focused ion beam (FIB) operation. At the end, it is then possible to collect the current flowing through the MTJs with a near-field probe.

To probe the MTJ resistance, two near-field techniques are investigated: conductive atomic force microscopy (C-AFM) and scanning spreading resistance microscopy (SSRM). C-AFM provides a quite high resistivity probably due to its sensitivity to contact resistance. Using SSRM, a resistance of 12 - 16 kΩ and 17 - 22 kΩ were determined for "0" and "1" bits, which is in agreement with literature.

...n an MRAM Cell, Following a Backside Opening, to Extract Logical Data

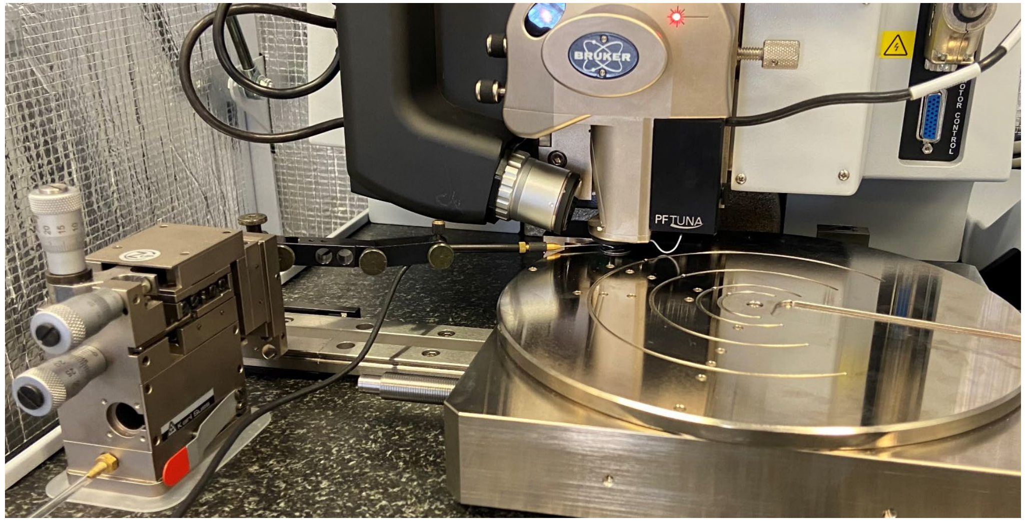
Louise Dumas, Guillaume Bascoul
...tre National d'Etudes Spatiales (CNES), Toulouse, France
louise.dumas@cnes.fr
Christina Villeneuve-Faure
...oratoire Plasma et Conversion d'Energie), Toulouse, France
François Marc, Hélène Fremont
Laboratoire IMS, France
Christophe Guerin
...ement Maîtrise de l'information (DGA MI), Rennes, France

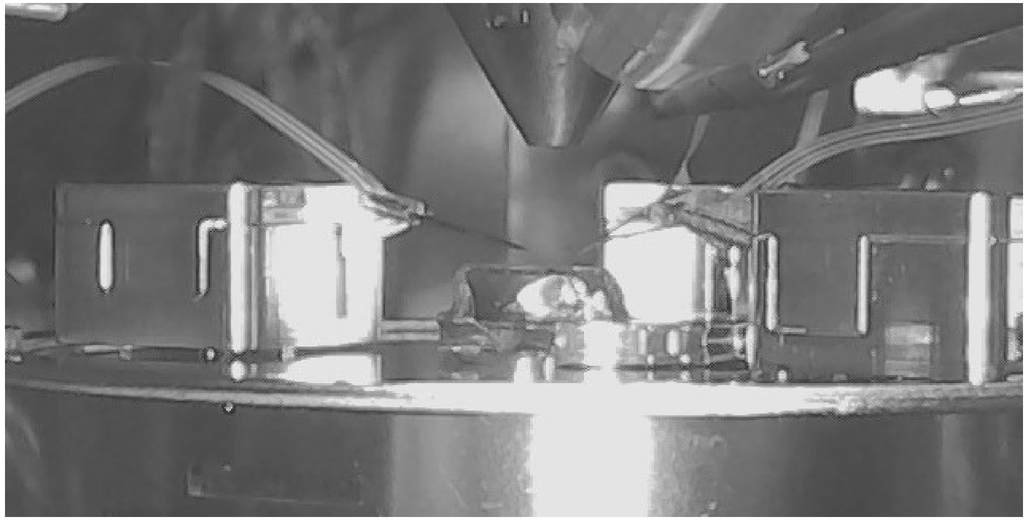
Méthode & Matériel

Préparation de la mémoire : Attaque chimique + Polissage → Destruction de l'accès électrique

Création d'un nouveau → Lecture des informations

Microscope (évolué) Nanorobots





Point commun : 2 pointes → Contrôle du courant

Résultats avec le Microscope

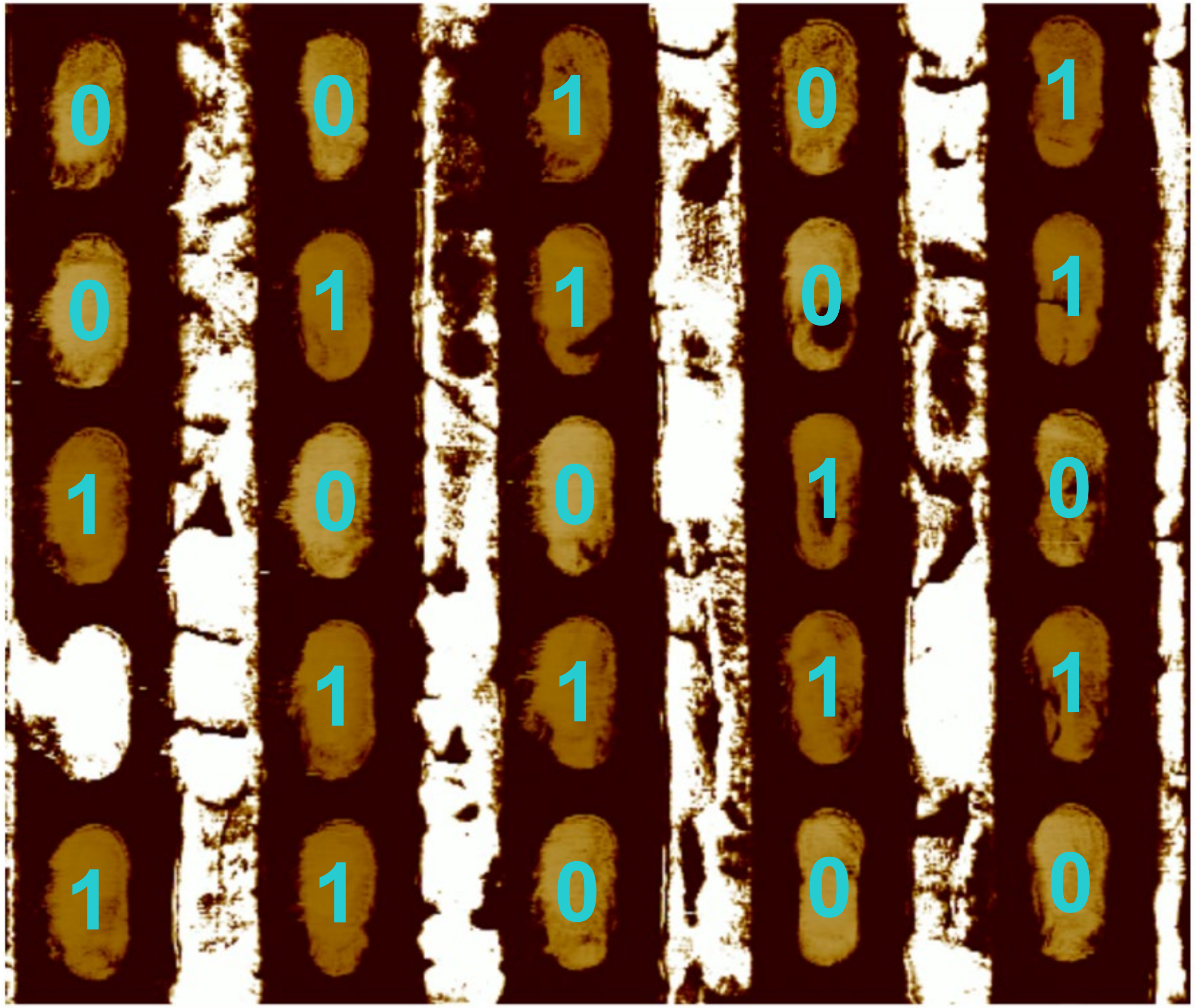


Image de courant : Identification de couleurs

ou

Détails + Nanoprobing → Poster

