Structure and magnetic properties of magnetic tunnel junctions with Ta/CuN/Ta and Ta/Ru/Ta buffer layers

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Aim

Structural and magnetic properties of CoFeB/MgO/CoFeB magnetic tunnel junctions strongly depends on buffer layers.

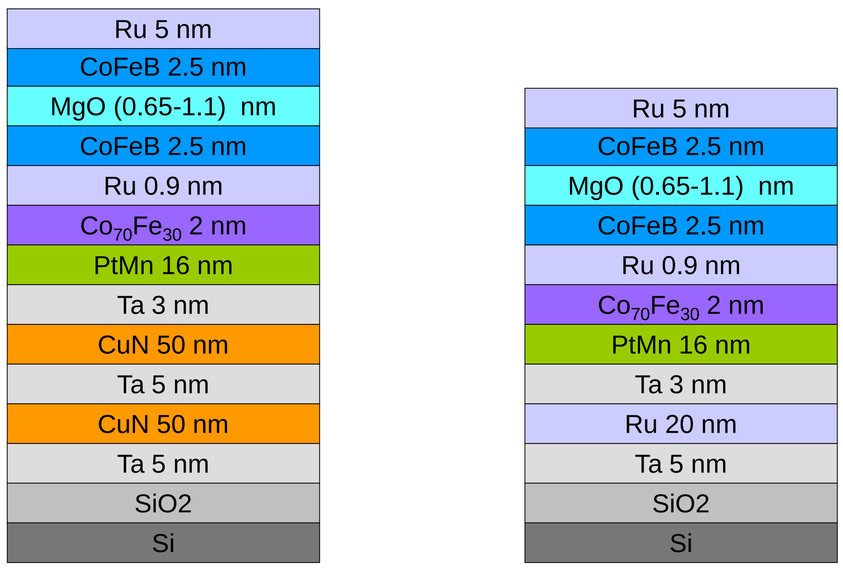
In this work we report two buffers Ta/CuN/Ta/CuN/Ta and Ta/Ru/Ta and its influence on on crystallization of PtMn antiferromagnetic layer, roughness of magnetic layers and interlayer coupling between CoFeB layers through variable thickness of MgO barrier.

Experiment

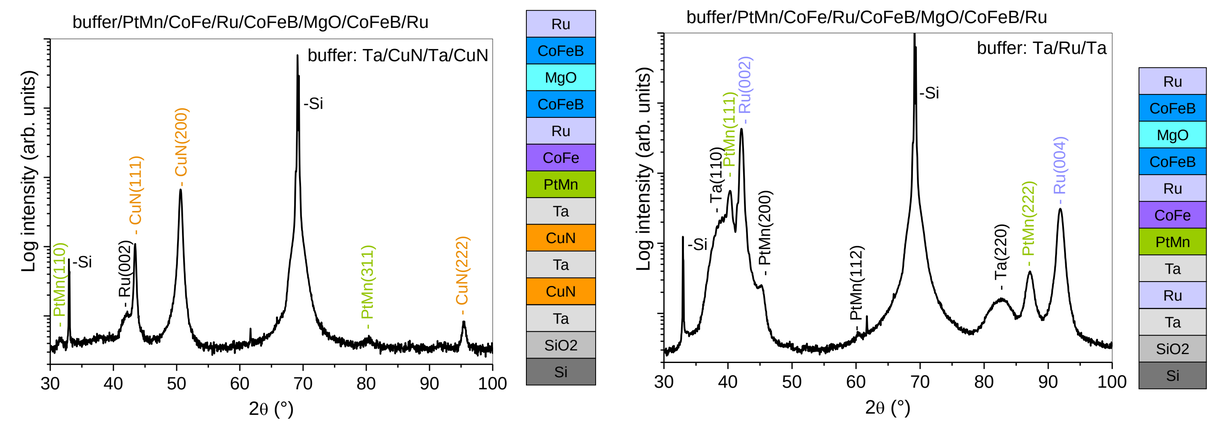
Multilayer structures, designed for magnetic tunnel junctions fabrication, were prepared with two different buffer layers: 5 Ta / 50 CuN / 3 Ta / 50 CuN / 3 Ta and 5 Ta / 20 Ru / 3 Ta (thicknesses in nm) and investigated in order to analyze the structural and the magnetic properties. Structure of the samples was as follows: buffer / 16 PtMn / 2.0 Co70Fe30 / 0.9 Ru / 2.5 Co40Fe40B20 / 0.6 - 1.1 wedge MgO / 2.5 Co40Fe40B20 / 5 Ru.

The samples were annealed in a high vacuum at 350 ºC for 2 hours in a magnetic field of 4 kOe. The microstructure of the MTJs were investigated using an x-ray diffraction (XRD), x-ray reflectivity (XRR) and atomic force microscopy (AFM) methods. The magnetic properties have been investigated by means of a vibrating sample magnetometer (VSM).

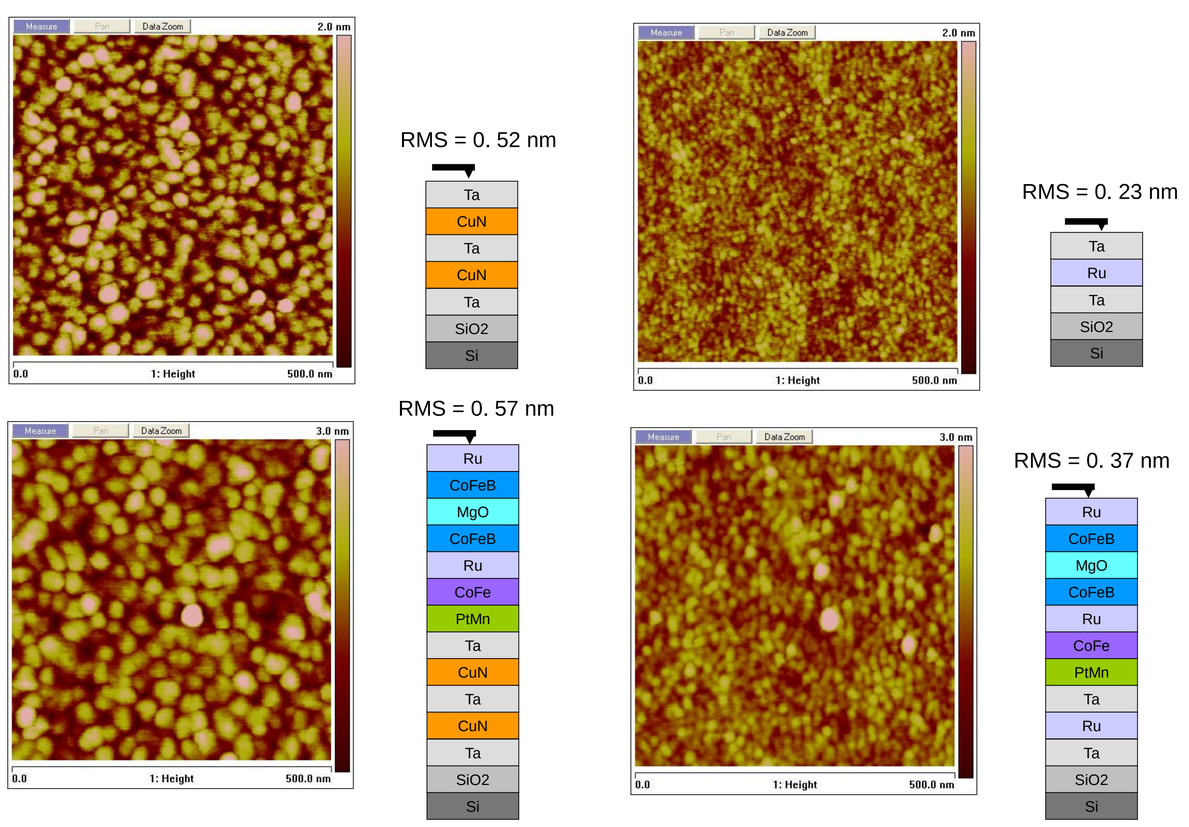
Samples Structure



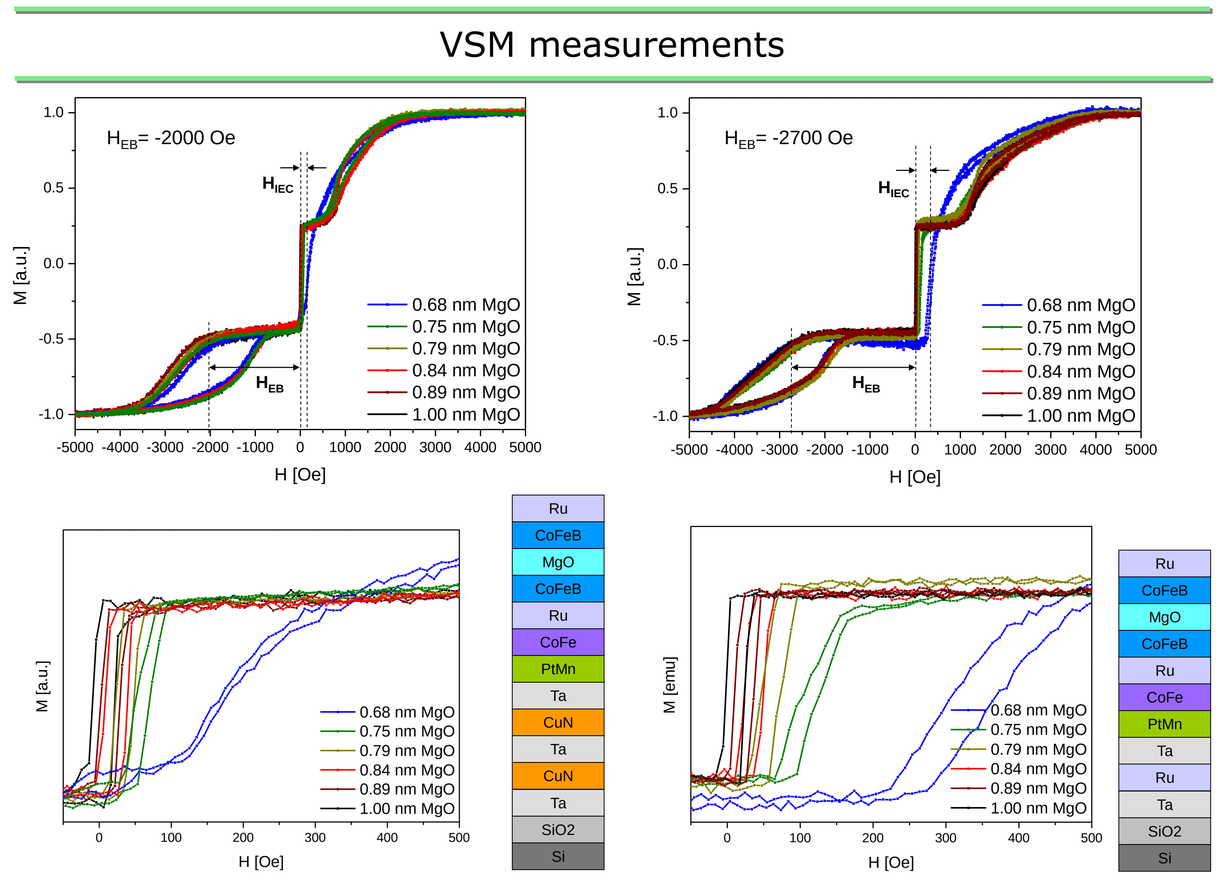
X-ray diffraction



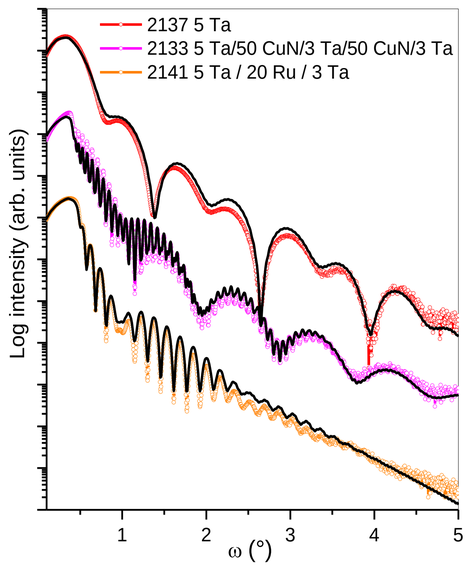
AFM measurements



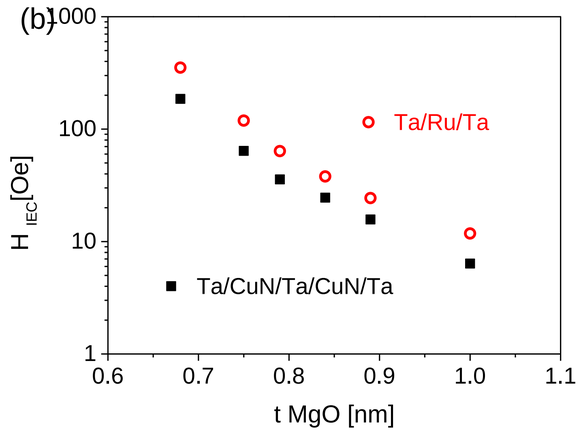
VSM measurements



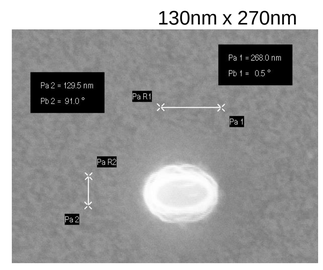
X-ray reflectivity

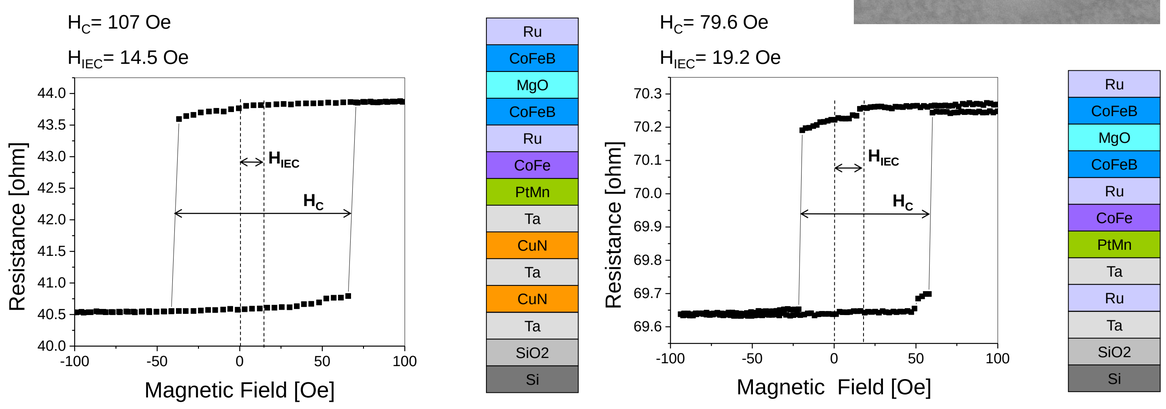


Interlayer Exchange Coupling



TMR measurements





Conclusions

- Microstructure of the layers in multilayer stacks strongly depends on buffers layers.
- Ru crystallized into a highly (002) oriented texture and the CuN crystallized in two orientations with planes (200) and (111) parallel to the sample surface.
- PtMn grown on the Ta/Ru/Ta exhibited highly (111) oriented texture whereas on the Ta/CuN/Ta/CuN/Ta the PtMn is disoriented.
- Higher exchange bias for the samples with Ta/Ru/Ta buffer (H_{EB}= -2700 Oe) than for the Ta/CuN/Ta/CuN/Ta buffer (H_{EB}= -2000 Oe) due to the higher texture of PtMn;
- Stronger ferromagnetic interlayer exchange coupling (IEC) of CoFeB layers (H_{IEC}) for the sample with Ta/Ru/Ta buffer than for the Ta/CuN/Ta/CuN/Ta. The minor loops shift depends on the MgO tunnel barrier thickness.

Acknowledgment

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