MAGNETIC PROPERTIES AND MAGNETIZATION DYNAMICS OF MAGNETIC TUNNEL JUNCTIONS BOTTOM ELECTRODE WITH DIFFERENT BUFFER LAYERS

J. Wrona[1,2], J. Kanak[2], M. Banasik[2], S. Ziętek[2], W. Skowroński[2] and T. Stobiecki[2]

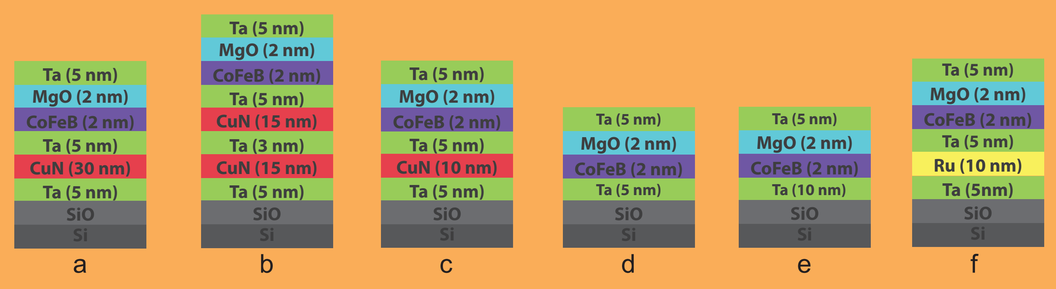
[1] Singulus Technologies AG, Hanauer Landstrasse 103, 63796 Kahl am Main, Germany
[2] AGH University of Science and Technology, Department of Electronics, Al. Mickiewicza 30, 30-059 Kraków, Poland

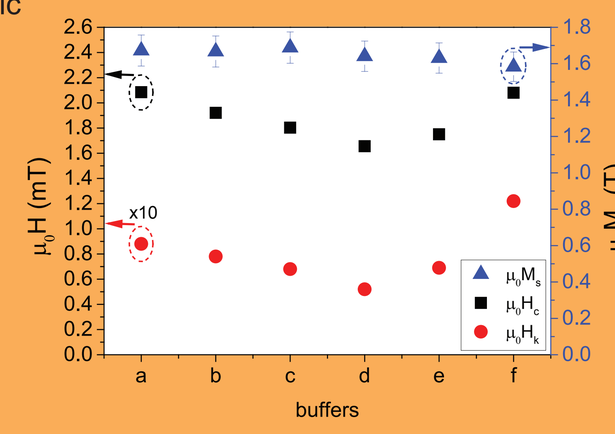
MOTIVATION

The magnetic properties of CoFeB layers strongly depend on the choice of the buffer layers. Their appropriate selection can provide more effective magnetic parameters what is essencial in such applications of magnetic tunnel junctions (MTJs) like magnetic field sensors [1] and magnetic random access memories (MRAMs).

We report the influence of roughness and crystallographic texture of different buffer layers on dynamic properties of CoFeB/MgO/Ta system as well characterize systems with several seed layers including buffers with Ta layers which are the focus of interest for research on spin Hall effect (SHE) [2].

The aim of this work was to investigate corellations between magnetic parameters like coercivity (H_c), anisotropy (H_k) fields, magnetisation (M_s) of magnetic tunnel junctions bottom electrodes and structural properties: texture and roughness which may also be related to the magnetization dynamics.





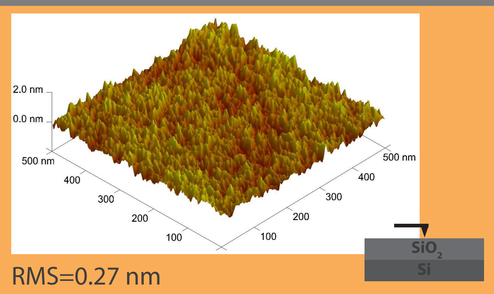
EXPERIMENT

AFM

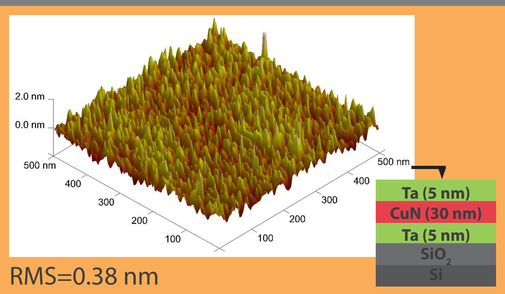
Buffer with CuN reveals large grains with diameter about 22 nm.

Significant grains are also for buffer with Ru, for sample (f) grains diammeter is about 15 nm.

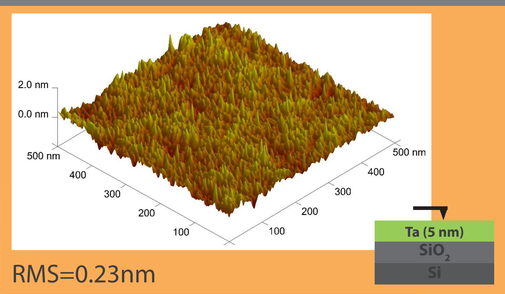
Ta gives small grains with diameter about 4 nm.



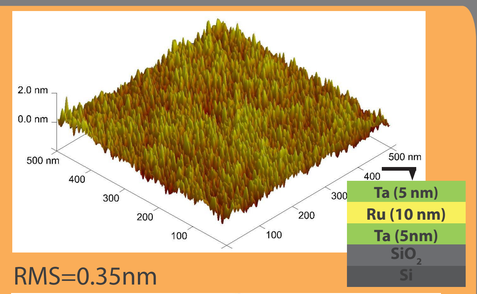
RMS=0.27 nm



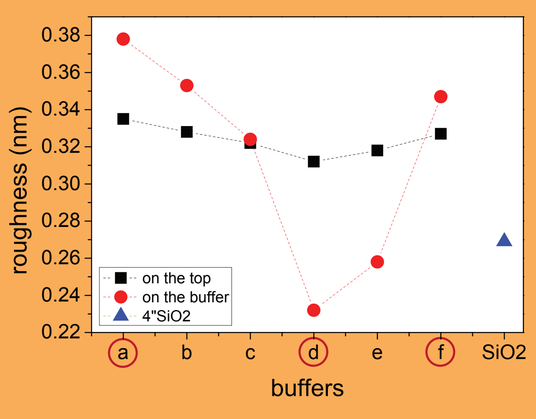
RMS=0.38 nm

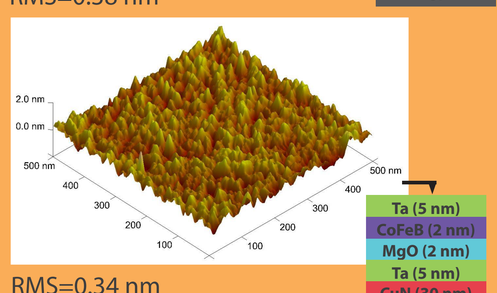


RMS=0.23nm

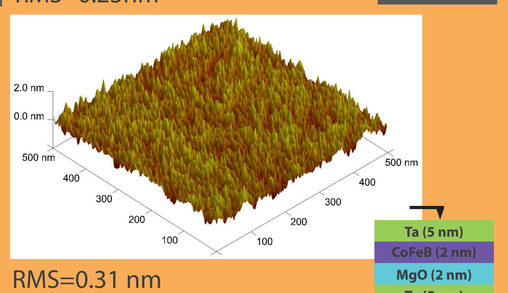


RMS=0.35nm

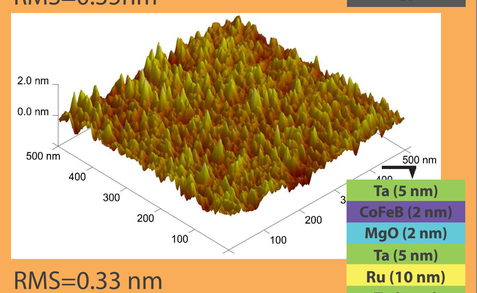




RMS=0.34 nm



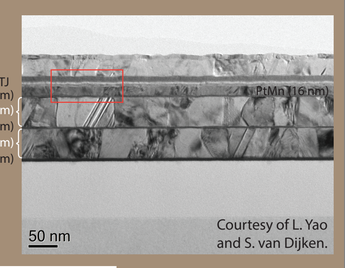
RMS=0.31 nm



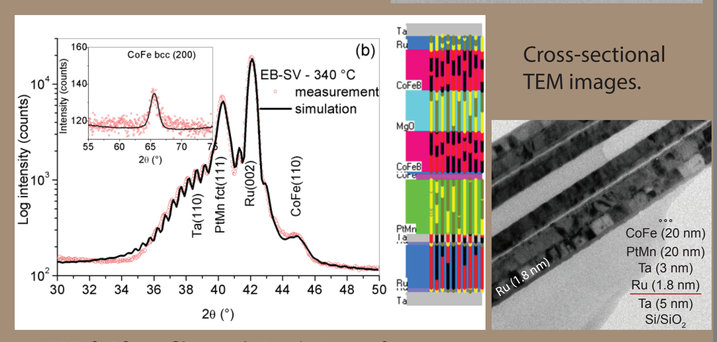
RMS=0.33 nm

DISCUSSION

Crystallization of amorphous CoFeB after annealing depends on the MTJ stacks and its position in the structure. The buffer layers strongly influence the topography of the upper layers.

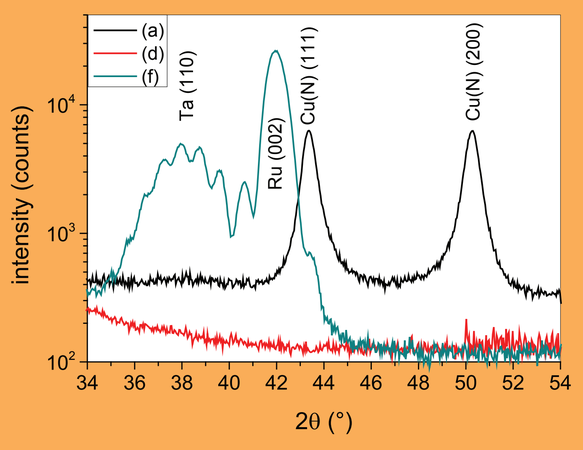


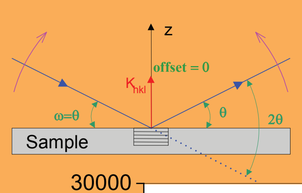
Cross-sectional TEM images.



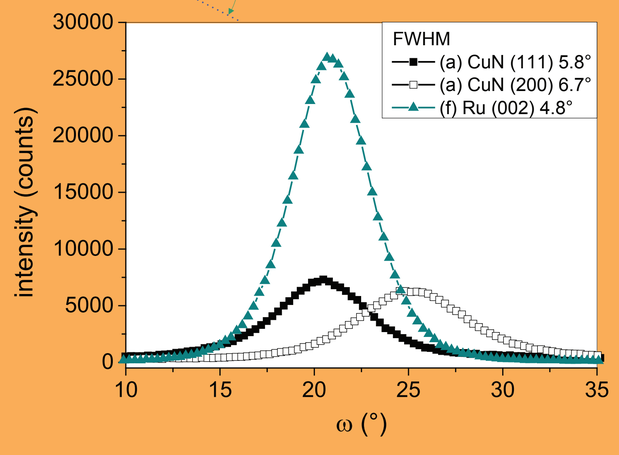
XRD θ-2θ profiles and simulations of crystalline columnar structures [3].

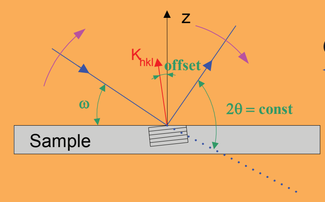
XRD





Θ-2Θ scan scheme

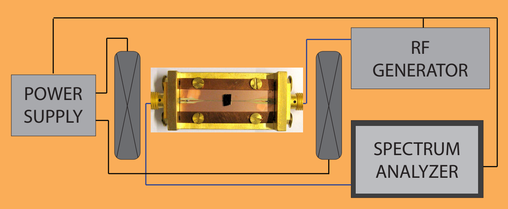


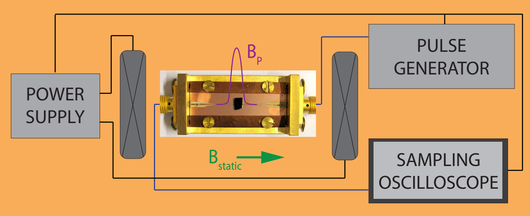


ω scan scheme

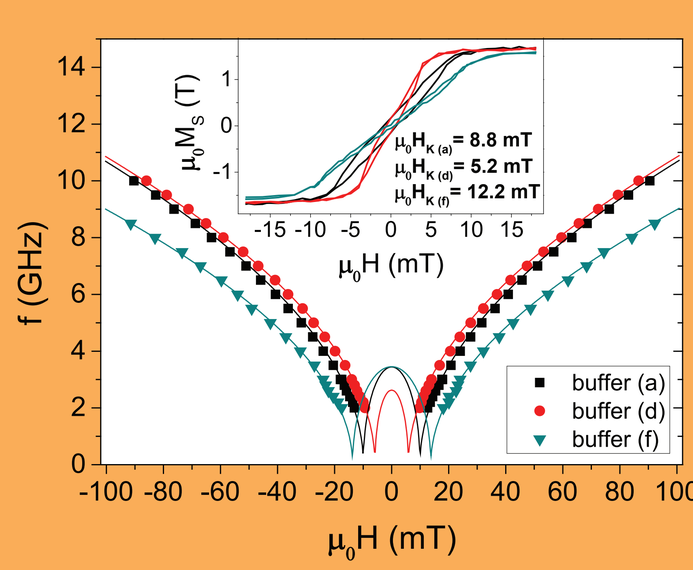
- The texture is the highest for buffer with CuN. CuN grew in two crystallographic orientations with fcc (111) and fcc (200) planes parallel to the sample surface.
- The texture of Ru is high which confirmed highly (001)-oriented growth of Ru buffer layer. Ru crystallized into hcp (001)-oriented texture.
- Ta layer with thickness 5 nm was amorphous.

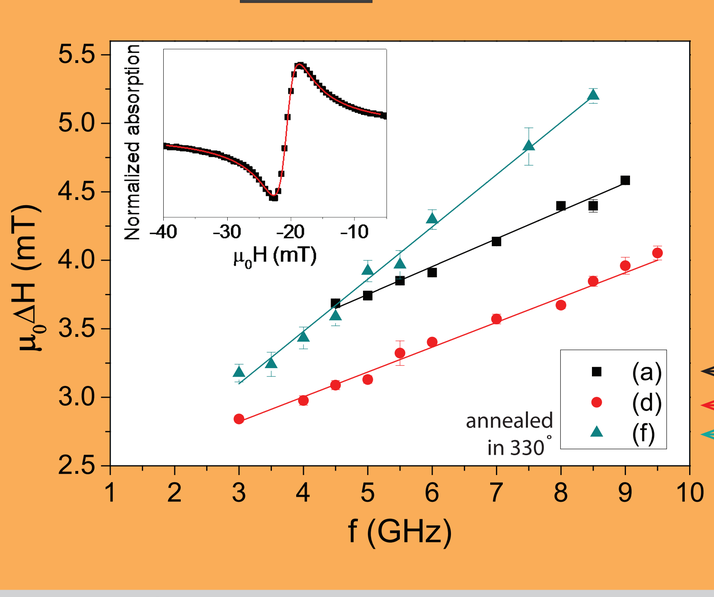
SNA-FMR



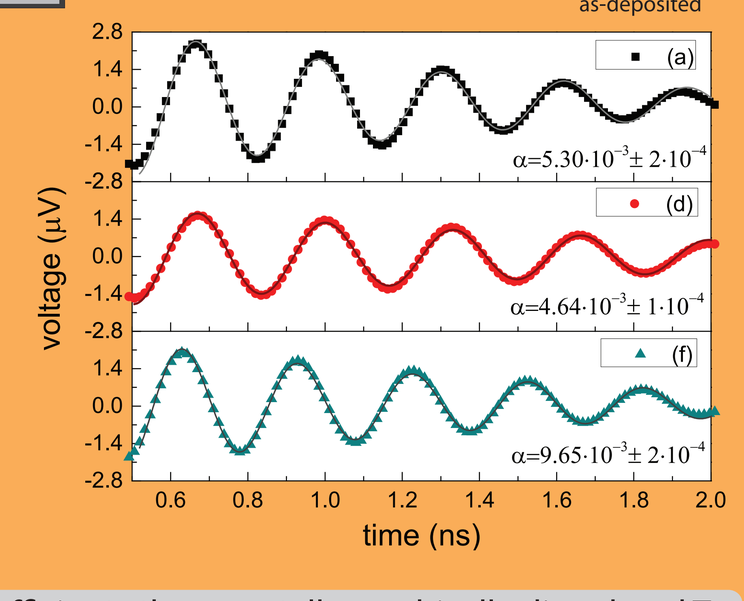


PIMM[4]





←α=5.7·10⁻³±2·10⁻⁴
←α=5.1·10⁻³±2·10⁻⁴
←α=10.7·10⁻³±3·10⁻⁴



The studies show that the well-textured and rough buffers Ta/CuN/Ta and Ta/Ru/Ta exhibit greater damping coefficients than crystallographically disordered Ta.

REFERENCES

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