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Paper: Structural optimization of MTJs with a composite free layer
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Speaker Biography:
Professor Siegfried Selberherr was born in Austria in 1955. He received the degree of Diplomingenieur in electrical engineering and the doctoral degree in technical sciences from the Technische Universität Wien in 1978 and 1981, respectively. Dr. Selberherr has been holding the venia docendi on computer-aided design since 1984. Since 1988 he has been the Chair Professor of the Institute for microelectronics. From 1998 to 2005 he served as Dean of the Fakultät für Elektrotechnik und Informationstechnik. Prof. Selberherr published more than 250 papers in journals and books. He and his research teams achieved more than 800 articles in conference proceedings of which more than 100 have been with an invited talk. Prof. Selberherr authored two books and co-edited 28 volumes, and he supervised, so far, more than 90 dissertations. His current research interests are modeling and simulation of problems for microelectronics engineering. Prof. Selberherr is a Fellow of the IEEE.

Invited Oral Presentation

Abstract text for Online or Printed Programs:
STT-MRAM is a candidate for future universal memory, however, improvement regarding the essential parameters is still needed. We investigate the switching statistics dependence on cell geometry by means of systematic micromagnetic simulations. We find that MTJs with a free layer composed of two ellipses with the axes a/2 and b inscribed into a rectangle a x b are characterized by the same switching speed and thermal stability as MTJs with a composite free layer (C-MTJs). Thus, while preserving all the advantages of the C-MTJs, the newly proposed structure can be easier fabricated, offering great potential for STT-MRAM performance optimization.

Abstract text for Technical Review Purpose:
Magnetoresistive random access memory with spin transfer torque (STT-MRAM) is a promising candidate for future universal memory. However, improvement regarding the essential parameters is still needed. Finding alternative architectures for magnetic tunnel junction (MTJ) structures is of considerable importance for the success of STT-MRAM. A MTJ with a composite free layer (C-MTJ) was proposed in our early work. The free magnetic layer of such a structure consists of two equivalent parts of half-elliptic form separated by a narrow non-magnetic spacer. The C-MTJs demonstrate a substantial decrease of the switching time and switching current as compared to the standard MTJ with the monolithic free layer. In this work, we perform the structural optimization of C-MTJs by means of extensive micromagnetic simulations and propose a new structure of the composite free layer, C2-MTJ. In a C2-MTJ the free layer consists of the two ellipses with the major axes a/2 and b (a>2b) inscribed into a rectangle a x b. This structure is easier to fabricate as compared to the previous generation of C-MTJs. We investigated the switching statistics depending on the geometry. We find that the new C2-MTJ switches as fast as the previous one, which is 2 times faster than the structure with a monolithic free layer, without loss of thermal stability. The narrow switching time distribution characteristic of C-MTJs is also preserved in C2-MTJs. Therefore, the newly proposed C2-MTJ offers greater potential for performance optimization of STT-MRAM devices.

Topics:
1. spin-transfer, micromagnetism
2. new structures and applications

Keywords:
magnetoresistive random access memory (MRAM)
spin transfer torque (STT)
magnetic tunnel junction (MTJ)
micromagnetic simulation