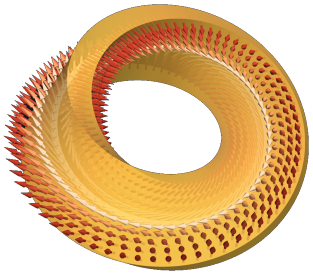

Contribution ID: **18** Type: **Invited talk**

3D reconstruction of magnetic textures in nanomagnets by electron holographic tomography

Thursday, 23 May 2019 14:30 (30 minutes)

The fundamental understanding of nanomagnetic phenomena such as domain walls in nanowires requires quantitative magnetization mapping techniques resolving textures down to the nanometer scale in 3D. In our contribution we report on the development of a tomographic reconstruction technique for all Cartesian components of the magnetic induction with a spatial resolution of slightly below 10 nm. To that end we combine off-axis electron holography (EH) and dual tilt-axis tomography in the transmission electron microscope (TEM). Electron holography allows to reconstruct projections of the magnetic flux density by an evaluation of the Aharonov-Bohm phase. The combination with tomography then facilitates the reconstruction of the 3D distribution of the Cartesian component parallel to the respective tilt axis from a tilt series of projections. Employing standard tomographic specimen holders only two perpendicular tilt axis and hence Cartesian components are currently accessible. The third component is evaluated by numerically integrating $\mathrm{div}\vec{B} = 0$. Going one step further, we derive the 3D magnetization distribution and other magnetic quantities such as the magnetization current from the reconstructed 3D magnetic flux density by invoking analytic and numerical micromagnetics.

Using this approach we reconstruct the remnant magnetic configuration of an electro-deposited Co/Cu multilayered nanowire (NW). We particularly reveal several characteristic magnetization states (vortex states or homogeneously magnetized) of the individual Co disk and correlate them to the structural and chemical composition of the NW. We discuss pertaining limits (e.g., resolution) and give an outlook to further instrumental development (such as 3-axis tomography holders). The powerful approach presented here is widely applicable to a broad range of 3D magnetic nanostructures and may help to elucidate a wide range of nanomagnetic configurations.

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