Scientists investigate Walker breakdown in 3-D magnetic nanowires

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FEFU spin nano lab, research equipment Credit: FEFU

Physicists from Russia, Chile, Brazil, Spain and the U.K., have studied

how the magnetic properties change in 3-D nanowires, promising materials for various magnetic applications, depending on the shape of their cross-section. In particular, they more deeply probed the Walker breakdown phenomenon, which may have implications for future technology development. The research outcome appears in *Scientific Reports*.

The cross-sectional geometry of a three-dimensional nanowire affects the domain wall dynamics and therefore is crucial for their control. In turn, managing the DW dynamics under external conditions is necessary in order to develop future electronics and computing devices operating on new physical principles. Such equipment will be faster, more reliable, smaller, and more energy-efficient. An example is magnetic memory, generators of magnetic signals and magnetic logic devices.

The domain wall dynamics in magnetic nanowires is curbed by the Walker breakdown phenomenon. That is the loss of the linear dependence of the velocity of domain walls on the magnitude of the external magnetic field when the field exceeds a critical value known as the Walker field.

"We managed to find out that the oscillatory behavior of the DW in a nanowire with a polygonal cross-section comes from energy changes due to deformations of the DW shape during the rotation around the nanowire. Thus, a deeper understanding of the Walker breakdown phenomenon is provided," says research participant Yuri Ivanov, a docent at the Department of Computer Systems, Far Eastern Federal University School of Natural Sciences. "We have studied 3-D nanostructures in which domain walls can oscillate not only along the nanowire but also around it. This double oscillation can be considered as a basis, when designing, for example, the sources of radiofrequency electromagnetic radiation (nano-oscillators) for smartphones of the new generation."

The production of 3-D magnetic nanowires is a fast-growing area of research. The material secures a special position among prospective magnetic nanostructures. The different cross-sectional shapes and curvatures of nanowires determine their dynamic and static magnetic properties. However, it is extremely difficult to study these properties due to the three-dimensional structure of the nano-objects.

Next, the scientists plan the development of a theoretical model to predict the change in the dynamic magnetic properties in 3-D nanowires of various cross-sections and curvatures.

More information: Dora Altbir et al, Tuning domain wall dynamics by shaping nanowires cross-sections, *Scientific Reports* (2020). DOI: 10.1038/s41598-020-78761-w

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