The transmission of spin wave affected by the location of an antidot defect within a waveguide

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In the past few decades, the field of nanomagnetism has made significant progress through extensive research into the magnetization dynamics in nanostructures. This has resulted in the discovery of new effects, the development of various applications, and the identification of promising new directions such as magnonics, which focuses on studying the dynamics of spin waves and their potential applications.

To investigate how the size and placement of a circular defect in a waveguide affect propagating spin waves and their transmission, we conducted micromagnetic simulations of a waveguide-defect system. Simulations were performed on a 768 nm wide Py waveguide with a defect diameter between 50 and 400 nm and a vertical displacement from the center of the waveguide every 50 nm towards the edge. To excite all frequencies, a broadband source was used.

According to our results, displacement and size changes have different effects on spin wave transmission in the waveguide. Using the transmission spectrum for the waveguide with varying sizes and displacements of the antidot defect, we distinguished three main areas. (i) In the low-frequency range up to 5 GHz, corresponding to the FMR frequency, we observe a change in the maximum frequency of the transmitted wave with a change in the diameter of the antidot defect. As the defect moves toward the edge, the transmittance of spin waves at low frequencies increases. These relationships can be used as a spin wave filtering at low frequency part of the spectra. (ii) In the range from 5 to 12 GHz, the resonance effects with multiple transmission maximums and minimums are observed which can be controlled by the defect placement. This interesting relationship shows the ability of using the system for controlling transmission channels. (iii) As the size and displacement from the center of the defect increase, the transmission amplitude decreases monotonously in high-frequency ranges above 12 GHz.

Our findings suggest that creating a defect in a waveguide is a viable method of controlling spin wave propagation, making it a promising technique for various applications, as a filters or demultiplexers.

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