Tuning all-optical magnetization switching efficiency by laser pulse wavelength variation

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Magnetization manipulation remains an indispensable tool in both, basic research, and application development [1]. Energy transfer from the electron system to the spins provides the basis for the response dynamics triggered by optical laser excitation determining the speed of ultrafast magnetization processes. In magnetic storage development, granular FePt gained special interest for heat-assisted magnetic recording [2]. In the meantime, writing experiments by single laser spots point to an asymmetric writing per laser shot. This was consistently observed by different research groups [3,4,5,6]. The interplay between the involved processes requires further investigation, opening further questions about the extension and possibilities for all-optical writing as a general mechanism. In the current understanding of interaction in ultrafast excitation and heating, the influence of magnetic dichroism and the presence of the inverse Faraday effect jointly work as forces causing magnetization reversal. We calculate the switching rates for individual FePt nanoparticles in ab-initio calculations of the optical effects (inverse Faraday effect and magnetic dichroism induced heating) included in thermal modelling. The latter then provides switching rates for the ensembles. We can trace the different processes from the beginning of the laser pulse impact [4]. This theoretical description allows us to optimize the required number of shots to reverse the magnetization of FePt nanoparticles and pinpoints how to optimize the all-optical writing by tuning the laser fluence and wavelengths. First experiments show, that tuning wavelengths requires simultaneous fluence adjustment due to the increased photon absorption for larger wave lengths.

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