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Engineered materials for all-optical helicity-dependent magnetic switching[1]

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The possibilities of manipulating magnetization without applied magnetic fields have attracted growing attention over the last fifteen years. The low-power manipulation of magnetization, preferably at ultra-short time scales, has become a fundamental challenge with implications for future magnetic information memory and storage technologies. Here we explore the optical manipulation of the magnetization of engineered materials and devices using 100 fs optical pulses. We demonstrate that all optical – helicity dependent switching (AO-HDS) can be observed not only in selected rare-earth transition-metal (RE-TM) alloy films but also in a much broader variety of materials, including alloys, multilayers, heterostructures and RE-free Co-Ir-based synthetic ferrimagnets. The discovery of AO-HDS in RE-free TM-based synthetic ferrimagnets can enable breakthroughs for numerous applications since it exploits materials that are currently used in magnetic data storage, memories and logic technologies. In addition, this materials study of AO-HDS offers valuable insight into the underlying mechanisms involved. Indeed the common denominator of the diverse structures showing AO-HDS in this study is that two ferromagnetic sub-lattices exhibit magnetization compensation (and therefore angular momentum compensation) at temperatures near or above room temperature. We are highlighting that compensation plays a major role and that this compensation can be established at the atomic level as in alloys but also over a larger nanometers scale as in the multilayers or in heterostructures. We will also discuss the potential to extend AO-HDS to new classes of magnetic materials. This work was done in collaboration with S. Mangin, M. Gottwald, C-H. Lambert, D. Steil, V. Uhlíř, L. Pang, M. Hehn, S. Alebrand, M. Cinchetti, G. Malinowski, Y. Fainman, and M. Aeschlimann.

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