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Probing depth-dependent spin textures in artificial skyrmions, magneto-ionic systems and HAMR media[1]

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Nanoscale spin textures such as skyrmions and domain walls have received intense interest due to their topological characteristics and potential applications in low power information storage. However, probing their depth-dependent magnetic configurations has been very challenging. Here we report a series of studies on depth-dependent spin textures in technologically important material systems, using a combination of magnetometry, magnetic imaging, polarized neutron reflectometry, x-ray magnetic circular dichroism, and spin transport techniques. In one study, we have achieved room temperature artificial Bloch skyrmion lattices in their ground state [1], as well as a new type of planar skyrmion lattices, without any magnetic nanodots protruding on top. In another study, we have demonstrated magneto-ionic control of metal/oxide interfaces, where the oxygen migration is observed and manifested in an interface-sensitive exchange bias effect [2]. We further show that the magnetoelectric coupling moderated by voltage-driven oxygen migration extends beyond the interface region in relatively thick films [3]. Finally, we have shown an extremely sensitive magnetic yoking effect and tunable interactions in FePt based hard/soft bilayers which are prototype heat-assisted magnetic recording media [4]. Work done in collaboration with J. Olamit, R. K. Dumas, B. J. Kirby, A. J. Grutter, B. B. Maranville, E. Arenholz, A. L. Balk, P. Fischer, D. T. Pierce, J. Unguris, J. A. Borchers, J.W. Liao, M. Winklhofer, C. H. Lai, and Kai Liu. 1. D. A. Gilbert, et al., Nature Commun. 6, 8462 (2015). 2. D. A. Gilbert, et al., Nature Commun. 7, 11050 (2016). 3. D. A. Gilbert, et al., Nature Commun. 7, 12264 (2016). 4. D. A. Gilbert, et al., Sci. Rep. 6, 32842 (2016).

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