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Spin and Magnetism in 2D Materials

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Our focus recently has been to develop 2D magnets and their heterostructures with topological insulators through thin film synthesis via molecular beam epitaxy (MBE). These are interesting materials for efficient magnetization switching by spin orbit torque and for topological states such as the quantum anomalous Hall effect. In this talk, I will highlight our efforts on the MBE growth of such materials and the development of ultrafast techniques to probe the magnetization dynamics and carrier dynamics. I will discuss the development of MnSe2 and integration with Bi2Se3 leading to the synthesis of MnBi2Se4, a layered antiferromagnet and magnetic topological insulator. For bilayer heterostructures, we learned how to synthesize 2D magnet Fe3GeTe2 on Bi2Te3(0001) with sharp interfaces, which is of interest for SOT switching. To quantify SOT, we have been developing a time-resolved magneto-optic Kerr effect (TR-MOKE) technique to directly measure the contributions of damping-like and field-like SOT on the magnetization precession. We have successfully employed this to investigate SOT in Fe3Sn2/Pt and are starting to employ this for 2D magnetic materials. Finally, I will conclude with some recent work on carrier and valley dynamics in nonmagnetic WS2 monolayers investigated by time-resolved, angle-resolved photoemission spectroscopy.