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Novel current driven domain wall dynamics in synthetic antiferromagnets[1]

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It was reported [1,2] that the domain walls in nanowires can be moved efficiently by electrical currents by a new type of torque, chiral spin torque (CST), the combination of spin Hall effect and Dzyaloshinskii-Moriya interaction. Recently we domonstrated that ns-long current pulses can move domain walls at extraordinarily high speeds (up to $\sim$750 m s$-$1) in synthetic antiferromagnetic (SAF) nanowires that have almost zero net magnetization [3], which is much more efficient compared with similar nanowires in which the sub-layers are coupled ferromagnetically (SF). This high speed is found to be due to a new type of powerful torque, exchange coupling torque (ECT) that is directly proportional to the strength of the antiferromagnetic exchange coupling between the two sub-layers, showing that the ECT is effective only in SAF not in SF. Moreover, it is found that the dependence of the wall velocity on the magnetic field applied along the nanowire is non-monotonic. Most recently we predict an Walker-breakdown-like domain wall precession in SAF nanowires in the presence of in-plane field based on the model we develop, and this extraordinary precession has been observed [4]. In this talk I will discuss this in details by showing a unique characteristics of SAF sublayers' DW boost-and-drag mechanism along with CST and ECT. [1] Kwang-Su Ryu, Luc Thomas, See-Hun Yang, and Stuart Parkin, "Chiral Spin Torque at Magnetic Domain Walls", Nature Nanotechnology 8, 527-533 (2013). [2] Satoru Emori, Uwe Bauer, Sung-Min Ahn, Eduardo Martinez, and Geoffrey S. D. Beach, "Current-driven dynamics of chiral ferromagnetic domain walls", Nature Materials 12, 611-616 (2013). [3] See-Hun Yang, Kwang-Su Ryu, and Stuart Parkin, "Domain-wall velocities of up to 750 m s$-$1 driven by exchange-coupling torque in synthetic antiferromagnets", Nature Nanotechnology 10, 221-226 (2015). [4] See-Hun Yang, Chirag Garg, Paul Amari, Charles Rettner, and Stuart Parkin, in preparation. [5] Stuart Parkin and See-Hun Yang, "Memory on the Racetrack", Nature Nanotechnology 10, 195-198 (2015).

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