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Temperature dependence of the spin torque effect in current-induced domain wall motion

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Rather than using conventional field-induced reversal, a promising approach for switching magnetic nanostructures is current-induced domain wall motion (CIDM), where due to a spin torque effect, electrons transfer angular momentum and thereby push a domain wall [1-4]. Since this interaction is strongly dependent on the wall spin structure, we have imaged domain walls in NiFe and Cobalt nanostructures and correlate the above mentioned effects with the imaged spin structure [1-4]. We find that both domain walls types can be moved due to the spin torque effect in the direction of the electron flow [2]. In addition to wall movement, changes in the wall spin structure have been predicted [2], and we have recently observed such wall type transformations using PEEM [3] and found that the velocity depends strongly on the wall type and the transformations occurring [3].
Temperature dependent measurements of field- and current-induced wall motion have shown that the critical fields for field-induced wall motion decrease with increasing temperature, which can be attributed to thermal excitations. The critical current densities for current-induced motion though have been found to increase with increasing temperature, which is opposite to the behaviour due to thermal excitations [4], and might be due to the influence of thermally activated spin waves [4]. Using constrictions, we have been able to probe the interplay between current-induced motion and the attractive potential wells that the constrictions generate at variable temperature. We find that we can not only move domain walls with currents even into areas, where no current is flowing but the temperature dependence is also a sensitive probe separating the influence of thermal excitation vs. the intrinsic temperature dependence of the spin transfer torque.

1. M. Kläui et al., PRL **94**, 106601 (2005); A. Yamaguchi et al., PRL **92**, 77205 (2004).

2. A. Thiaville et al., EPL **69**, 990 (2005).

3. M. Kläui et al., APL **88**, 232507 (2006).

4. M. Laufenberg et al., PRL **97**, 46602 (2006).