Comment on "Exchange Bias Dependence on Interface Spin Alignment in a $Ni_{80}Fe_{20}$/(Ni, Fe)O Thin Film"

In 1956, Meiklejohn and Bean [1] discovered the shift in the hysteresis loop of exchange-coupled ferromagnetic/antiferromagnetic (FM/AFM) systems in a direction opposite to that of the field applied during the cooling procedure, i.e., "negative" exchange bias (EB). Soon after, Meikelejon and Carter [2] showed that the shift could also be in the applied field direction. This "positive" EB became largely known after a study on Fe/FeF_2 [3] was published. In a recent Letter, Ouyang *et al.* [4] claim that their Py/(Ni, Fe)O film exhibits negative EB after 20 kOe field cooling, and positive EB when *zero-field* cooled (ZFC). In this Comment, we argue that the authors did not provide convincing evidence for the claimed positive EB, which could well be an artifact. Our experimental data point to the feasible origin of the claimed positive EB.

Generally speaking, if no magnetic field of any kind is present during the sample deposition and the cooling process *prior* to the hysteresis loop trace, it is highly unexpected that unidirectional anisotropy would be established that favors any spacial direction (according to the authors, however, it exists, i.e., the positive direction of the field used in the *posterior* hysteresis loop trace at low temperature). Let us recall that the role of the magnetic field during cooling is to align the FM moments that in turn, below the Néel temperature (T_N), align the AFM spins, thus resulting in EB. Note that the field needed to saturate a good-quality Py could be as small as few Oe (comparable to the remnant fields of the superconducting magnets). If no special care is taken to keep the Py sample demagnetized, it could be easily saturated in a very small field (Ouyang *et al.* wrote, see their Ref. [6], that the samples' magnetization was measured after being structurally characterized).

Figure 1 shows our results for a 20 nm thick Py/(Ni, Fe)O film. Before cooling off the sample, a 100 Oe field of either positive (loop 1) or negative (loop 2) polarity was applied and turned off, and the hysteresis loops were plotted at 5 K. While the first loop shows a negative EB, in the second one it is positive. We stress that although in both cases the remnant field of the magnet in which the sample is cooled is about −6 Oe (as determined by the onset of the magnetization field dependence of paramagnetic Pd, measured before and after recording the loops), EB of different signs were recorded.

Note that although the cooling conditions in our experiment differ from those claimed in Ref. [4] (we could not afford removing all liquid helium and warming the system prior to the experiment), this does not change qualitatively the output from our experiment. The important result is that both negative and positive EB could be observed under the same cooling conditions, *depending on the history* of the Py film, as long as the coercivity of the sample is higher than the cooling field, which obviously includes the ZFC

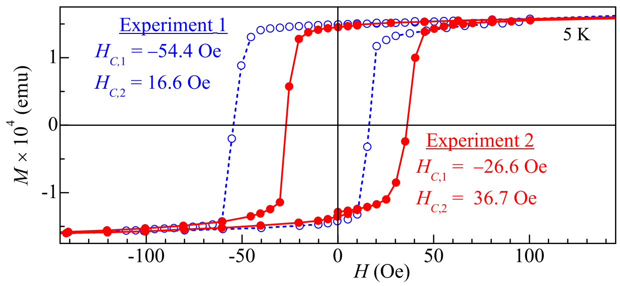

FIG. 1 (color online). Hysteresis loops at 5 K after applying and turning off 100 Oe magnetic field with "+" polarity (Experiment 1) and "−" polarity (Experiment 2) at 300 K and subsequent cooling down in the presence of remnant field of about −6 Oe. Note that the remnant field is superimposed on the applied field; hence the coercivity (H_C) values from the plots should be corrected correspondingly.

case claimed in Ref. [4]. We believe that if the sample of Ouyang *et al.* is carefully demagnetized prior to ZFC, it will exhibit neither positive nor negative EB, as one should expect.

The authors ascribed the positive EB to AFM spins orientated *perpendicularly* to the interface, estimated by correlating the Py and NiO crystallographic structures (NiO [111]-textured perpendicularly to the interface) with known magnetic configurations based on their Ref. [17]. There, however, contrary to the assumption of Ouyang *et al.*, one reads that the AFM moments are *parallel* to the substrate. Indeed, it is well established that, below T_N, a contraction of the fcc NiO lattice along different ⟨111⟩ axes causes the spins to lie in ferromagnetically ordered (111) planes [5].

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Received 24 June 2007; published 24 January 2008
DOI: 10.1103/PhysRevLett.100.039701
PACS numbers: 75.70.Cn, 68.37.Lp, 68.55.−a, 75.70.Ak

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