

## Symmetry breaking induced exchange bias in pure ferromagnetic system

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The exchange bias, the hysteresis loop shift in F(ferro)/AF(antiferro) system, has been extensively studied due to its valuable applications for example, spin valves and other devices of magnetic storage technology. The origin of exchange bias is time reversal symmetry breaking in AF layer, which results unidirectional anisotropy in F layer. We demonstrate that the time reversal breaking due to vicinal surface of substrates can induce exchange bias in pure ferromagnetic system which is constructed without AF material. Ferromagnetic Ni/Cu/Co and Ni/Fe/Co sandwiches were grown epitaxially on to vicinal Cu(001) substrate and investigated using surface magneto optic Kerr effect and X-ray magnetic circular dichroism techniques. We find that the atomic steps of the vicinal surface break the magnetic time reversal symmetry to induce an exchange bias in the Ni perpendicular magnetic hysteresis loop. The Ni exchange bias direction can be switched by changing the direction of the in-plane Co magnetization. In addition, the exchange bias can be tailored by changing the Cu or Fe spacer layer thickness.