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400-Fold Reduction in Saturation Field by Stress Relief in Multilayers WILLIAM EGELHOFF, JOHN BONEVICH, CARLOS BEAUCHAMP, GERY STAFFORD, JOHN UNGURIS, NIST, PHILIP PONG, University of Hong Kong, ROBERT MCMICHAEL, NIST — A common problem in soft magnetic thin films is increased saturation field due to stress buildup with increasing thickness. We have found a solution to the problem using multilayers of a magnetic thin film and a film that is either not lattice matched or has a different crystal structure. Reductions in the saturation field as large as 400 fold are found. The ultrasoft $Ni_{77}Fe_{14}Cu_5Mo_4$ alloy can have saturation fields as small as 0.005 mT (0.05 Oe) for 10 nm thick films. However, for films 400 nm thick (which are needed for some applications) the saturation field is typically 20 mT. Splitting this magnetic thin film up into segments 100 nm thick separated by a 5 nm Ag film reduces the saturation field to 0.05 mT. Alternatively, using a 2 nm CoFe film yields a saturation field of 0.1 mT. A tensile stresses of 7.35 x 10^9 dynes/cm^2 was measured in the 400 nm film and 3.7 x 10^7 dynes/cm^{2}for the multilayer with Ag. The highly-stressed $Ni_{77}Fe_{14}Cu_5Mo_4$ develops a magnetostriction coefficient of $\sim$5 ppm, although in the unstressed state its magnetostriction coefficient is near zero. In conclusion, we have found a solution to the stress-induced large saturation fields in an otherwise soft magnetic film. The results should be important for ultra-low magnetic-field tunnel-junction sensors and magnetic flux concentrators.

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