Strong magetoelectric effect in the Tb-Pb cluster-based thin-film heterostructures

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Magneto-electric films have drawn a continual attention due to the potential application in the microelectro-mechanical devices (MEMS). We have developed low energy beam deposition (LECBD) to prepare the nanostructured thin-films and then fabricate the well-defined multi-layered heterostructures which consist of R-Fe alloy and ferroelectric oxides. Such nanostructured Tb-Fe film possesses higher magnetostriction than the common Tb-Fe films prepared by other methods, for instance, its magneto-striction reaches ~1060x10^{-6} at H_{bias} = 7.8 kOe, because of the large magnetic anisotropy in the film. Moreover, in the whole LECBD process, the phase formation of Tb-Fe nanoclusters is achieved in the condensation chamber with high temperature, while the depostion of Tb-Fe nanocluster beam ont the substrate is performed in the following high vacuum chamber with low energy and low temperature. These two steps are independent of each other. Therefore, even if the substrate is ferroelectric oxide, the degree of the interfacial reaction or diffusion between Tb-Fe alloy and ferroelectric oxide would be greatly suppressed. [1,2] We have further prepared Tb-Fe/PZT bilayer thin-film heterostructure with clear interface and strong magnetoelectric coupling, i. e., the induced voltage increment $|\Delta V_{ME}|$ = 14μV at H_{bias} = 5.5kOe, in this case the maximum increment of the magnetio electric voltage coefficient is ~ 140 mV/cm Oe, larger than that of the reported all oxide ferroelectric – ferromagnetic composite films.[3,4] The experiments demonstrate that this kind of cluster-based heterostructure not only exhibits good ferroelctric and ferromagnetic properties but also the strong magnetoelectric effect, and may opens an ideal avenue to manufacture the magnetoelectric composite films, applicable to MEMS devices in future.

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