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Giant cryogenic reversible magnetostriction in rare-earth free MnCo(Ni)Si metamagnetic alloys

Magnetostrictive materials, which exhibit the a mechanical strain when subject to a magnetic field, have attracted tremendous investigative interest because of their potential in constructing multifunctional devices. However, limited magnetostriction coefficient, expensive raw-materials cost, narrow working temperature range around room temperature and intrinsic irreversibility of the traditional magnetostrictive materials and ferromagnetic shape memory alloys severely restrict the usage of these materials under extreme environments. In this work, we report a giant cryogenic magnetostriction up to 10600 ppm in [100]Orth oriented MnCoNiSi alloys, exhibiting reversibility, inexpensive price, cyclic stability over a broad operation-temperature and composition range. Such a giant magnetostriction implies that the [100]Orth oriented has an enhanced magnetostrictive coefficient of × 2.25 compared with [111]Orth oriented MnCoSi alloy. In situ neutron powder diffraction measurements provide evidence that the magnetic structures have been changed after doping with Ni, generating an enhanced magnetostriction and cryogenic magnetostrictive response. Our work would inspire the study of the giant magnetostrictive effect with excellent cyclic service performance in a wide range of metamagnetic transformation materials.

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