Martensitic transformation and magnetostrictive effect of textured MnCoSi-based alloys

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Abstract

MnCoSi-based alloys, as a new type of magnetically controlled functional alloys, have attracted much attention because of their rich magnetic structures(1) and excellent functional behaviors such as magnetocaloric, abnormal thermal expansion, and magnetostrictive. Considerable efforts have been devoted to developing high-performance MnCoSi-based alloys. To date, fully dense and textured MnCoSi-based alloys have been achieved by adjusting the thermal treatment process(2, 3). The critical field of metamagnetic transition behavior can be substantially reduced by chemical doping and modification. To further improve the mechanical properties and magnetic response of MnCoSi-based alloys, it is still urgent to find a feasible strategy based on microstructure and texture optimization.
In the present work, (100) textured MnCoSi alloys were fabricated by slow-cooling thermal treatment. Microstructure and crystallographic characterization revealed that the textured MnCoSi alloy consists of three different oriented orthorhombic TiNiSi-type martensite variants with their a-axis lying in the cross-section of the rod-like MnCoSi alloy. A reversible giant negative thermal expansion of 9350 ppm with a broad temperature span of 350 K was obtained, due to the antiferromagnetic rearrangement(4). For the stoichiometric MnCoSi alloy, giant reversible magnetostrictions as much as –5268 ppm at 300 K were achieved. By substitution of Si with Ge element, a linear magnetostrictive effect below 2 T was observed in the MnCoSi0.84Ge0.16 alloys(5), due to the low critical field and the barrier of the interfaces between the variants.

References

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