Research on Abnormal Thermal Expansion Properties of MnNiGe-based Compounds

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Negative thermal expansion(NTE) materials is very important for obtaining near zero thermal expansion(NZTE) materials which could ensure the structural stability and safety reliability of precision parts and thus have wide application in engineering field. This study aims to explore new NTE materials responding in wide temperature range and then obtain NZTE materials by combining NTE materials with positive thermal expansion materials. In this study, Mn0.92Fe0.08NiGe alloy were prepared by a solid-state reaction using metal Mn, Ni, Fe and Ge as raw materials. The results of DSC and magnetic measurement show that magnetic phase transition happened at 398 K without structural transition. Variable temperature X-ray diffraction results indicate that the total unit cell volume decreases with increasing temperature from 175 K to 380 K, which means that NTE happened. The observed NTE is closely related to the change of orthorhombic and hexagonal phase fraction. The NTE temperature window is in agreement with that of the decreasing of magnetization from 175 K to 390 K. The coefficient of thermal expansion (CTE) for the composite Mn0.92Fe0.08NiGe/15 wt% Cu is -64.9219×10-6 K-1 (119–274 K).When the content of Cu increases from 15% to 70%, the absolute value of CTE decreases from 64.9219×10-6 K-1(119–274 K) to 4.7381×10-6 K-1(173–229 K), reaching near ZTE. Thus, the CTE of this kind of composites is controllable by adjusting the composition and finally the ZTE materials could be obtained.

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