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Effects of Mechanical Milling and Sintering Temperature on the Densification, Microstructure and Tensile Properties of the Fe-Mn-Si Powder Compacts

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This work reported on the effects of mechanical milling and sintering temperature on the densification, microstructure and mechanical properties of the Fe-28Mn-3Si (wt%) alloy. Elemental Fe, Mn and Si powders were used as the starting materials, and two batches of powder mixture were prepared: one was blended elemental (BE) powder mixture; the other was mechanically milled (MM) powder mixture milled for 5 h using planetary ball milling. Both powder mixtures were pressed under a uniaxial pressure of 400 MPa, and subsequently sintered in a high vacuum furnace for 3 h at 1000, 1100, 1200 and 1300 °C. It was found that Mn depletion region (MDR) was formed on the surface of all the sintered samples. The sintered BE compacts had a low density (< 68.2%) at all temperatures, while the density of the sintered MM compacts increased drastically from ~65% at 1000 °C to ~91% at 1300 °C. All the sintered MM compacts were composed of a predominant γ -austenite and minor ϵ -martensite. In comparison, additional (Fe, Mn)₃Si phase was observed in the BE alloys sintered at 1000 °C, and a single α -Fe phase was identified in the BE compact sintered at 1300 °C. The tensile properties of the sintered MM compacts increased significantly with the temperature and were significantly higher than those of their BE counterparts.

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