Synthesis and kinetic study of (Mo,W)Si ²-WSi ² nanocomposite by mechanical alloying

Abstract:

In this study, nanocomposite of (Mo,W)Si2–WSi2 was synthesized via mechanical alloying (MA) and heat treatment. The phase transformation of the powders after various milling durations and annealing was investigated by X-ray diffraction (XRD) and differential thermal analysis (DTA). Microstructural evolutions were characterized by scanning electron microscopy and transmission electron microscopy (TEM). Increasing the milling time to 80 h caused the formation of (Mo, W, Si) solid solution, t-(Mo,W)Si2, h-WSi2 phase, and a trace amount of unreacted raw material. However the post-annealing at 1000 °C caused the complete formation of (Mo,W)Si2–WSi2 nanocomposite. The values of the grain growth exponent of t-(Mo,W)Si2 phase for the powders milled for 40 and 80 h were 0.3 and 0.8, respectively, at 1000 °C. The grain growth activation energy of t-(Mo,W)Si2 phase for the 80 h milled powders (97.19 KJ/mol) was lower than that for the 40 h sample (120.83 KJ/mol). The crystallite size of t-(Mo,W)Si2 decreased to 32 nm (40 h) and 24 nm (80 h) with increasing milling time. However, the crystallite size of the milled samples increased to 60 and 87 nm after annealing at 1000 °C for 90 min. The DTA results of the as-milled specimens showed two exothermic peaks at around 600 and 900 °C relating to the formation of t-(Mo,W)Si2 and h-WSi2, respectively. The formation activation energy of t-(Mo,W)Si2 was higher (144.58 KJ/mol) for the 80 h milled sample compared to the 40 h milled sample (131.61 KJ/mol). The microhardness of (Mo,W)Si2–WSi2 nanocomposite increased with increasing milling time to 1020 Hv but decreased with escalating annealing temperature to 726 Hv.