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纳米晶W-Ni-Fe粉末的流变行为和烧结特性

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摘要: 研究了W-Ni-Fe纳米晶粉在注射成形中喂料的流变行为. 纳米晶W-Ni-Fe粉采用机械合金化(MA)的方法制备, 并将其与蜡基粘结剂混合形成1种喂料. 讨论了MA球磨时间、纳米晶粉末体积和温度对喂料流变性的影响及采用MA制备的W-Ni-Fe纳米粉末的烧结特性. 结果表明: 随着球磨时间增加, 喂料的粘度以及粘度对剪切速率的敏感性降低, 因此, 在较长的球磨时间下, 这种粉末喂料的流动性和成形性较好; 随着粉末体积的增加, 喂料的粘度遵循公式 $\eta = \eta_0 A [1 - (\varphi/\varphi_m)]^{-n}$ 呈非线性增加, 此时 $n=0.68$; 随着温度和剪切速率的变化, MA粉末喂料的粘度变化较小, 所以注射温度和注射速度的变化对这种MIM注射坯的质量影响较小; 在液相烧结温度以下通过球磨, 合金可达到很高的密度, 晶格畸变增大, 晶粒细化, 固溶体超饱和, 强化了烧结工艺.

关键词: W-Ni-Fe合金; 纳米粉; 粉末注射成形

Rheologic behavior and sintering characteristic of nanocrystal W-Ni-Fe powder

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Abstract: The rheologic behavior of the nanocrystal W-Ni-Fe powder feedstock in MIM process was studied. The nanocrystal W-Ni-Fe powder was prepared by mechanical alloying (MA), and then was mixed with wax-based binder to form the feedstock. The effects of MA time, powder volume and temperature on the rheologic behavior of the feedstock were discussed. The feedstock viscosity and its sensitivity to the shear rate decreased with increasing milling time. Therefore, the flow ability and compactability of the feedstock were proved to be good after milling for a long time. With the volume content of the powder increasing, the viscosity of the feedstock increased nonlinearly according to the following formula: $\eta = \eta_0 A [1 - (\varphi/\varphi_m)]^{-n}$ (where $n=0.68$). The viscosity of the MA powder feedstock was influenced a little by the temperature and the shear rate, so the injection temperature and rate had little influence on this kind of green parts. The sintering characteristics of this MA-prepared W-Ni-Fe powder were also studied. The results showed that milling had led to a high alloy density when sintering below liquid phase temperature, and the sintering rate was accelerated by large crystal distortion, grain refining and supersaturated solid solution.

Key words: W-Ni-Fe alloy; nanopowder; powder injection moulding

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