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铝合金盘型件等温辗压过程中晶粒尺寸演化的数值模拟与实验验证

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Numerical Simulation and Experimental Validation of Grain Size Evolution During Double-sided Isothermal Roll Forming for Aluminum Alloy Discal Parts

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摘要 为了揭示盘型件双面辗压成形过程中微观组织的演化特征,应用数值模拟方法研究了这一成形过程中所发生的动态再结晶和晶粒长大规律.所研究的盘型件材料为铝合金6061,辗压成形温度为350~500 ℃.晶粒尺寸演化规律的数值模拟结果与实验结果基本符合.与整体锻造不同,双面辗压成形没有变形死区,并且越靠近盘型件表面晶粒细化效果越好;辗压头通过对盘型件厚度方向压缩和表面环向剪切两种方式驱动盘型件变形.计算结果表明,即使压下量零增量辗压也会在沟槽附近产生显著变形和晶粒细化,这说明盘型件变形和组织演化主要源于辗压头对盘型件表面的环向剪切;多遍次辗压过程中,第1遍次辗压对晶粒细化的贡献最大,后续辗压的贡献较小;提高成形温度可能会出现动态晶粒长大区,在这种情况下,盘型件上的点将交替发生动态再结晶和动态晶粒长大,最终晶粒尺寸会有一定程度增加.

关键词: 双面辗压成形 数值模拟 晶粒尺寸 晶粒细化 晶粒粗化 盘型件 铝合金

Abstract: The dynamic recrystallization and grain growth of discal parts during the double-sided roll forming process are studied by numerical simulation and experimental validation in order to discover the microstructure evolution characteristics in the process. In the study, the disc material is aluminum alloy 6061, and the forming temperature is 350-500 ℃. The conclusion obtained is as follows. The results on grain evolution and its tendency from the test and calculation are in agreement. An important difference of the double-sided roll forming from integral forging of discal parts is that there are no zero strain regions in the rolled part, and that the closer it is to the groove surface, the better is grain refinement. Even rolling with zero increment of compression will cause a nonzero increment in deformation and grain refinement near the rolled groove. For repeated rolling, the contribution of the first rolling to grain refinement is more than that of the subsequent rollings. Higher forming temperature may cause grain growth where dynamic recrystallization and grain growth may appear alternately to cause the increase of final grain size to a certain extent.

Keywords: double-sided roll forming numerical simulation grain size grain refinement grain coarsening discal part aluminium alloys

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