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高能超声对原位合成 $Al_3Ti/6070$ 复合材料凝固组织的影响及机制

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摘 要: 以 $Al-K_2TiF_6$ 为反应体系, 采用熔体反应法, 在高压超声场下原位合成 $Al_3Ti/6070$ 复合材料。采用XRD、SEM、EDS等手段研究不同超声参数如超声时间和超声强度对 $Al_3Ti/6070$ 复合材料增强体形貌及尺寸的影响。建立了超声作用下熔体中颗粒行为模型, 并对其机制进行了探讨。结果表明: 在一定的超声强度下(0.66 kW/cm^2), 颗粒尺寸随超声作用时间的延长(1~7 min)先减小后增大, 当作用时间为3 min时, 颗粒最细小, 尺寸为1~2 μm , 形貌主要为小块状或短棒状; 当超声作用时间大于3 min时, 颗粒数量随时间增加而急剧减少; 在相同的超声作用时间(3 min)下, 颗粒尺寸随超声强度的增加而减小, 当超声强度为 0.82 kW/cm^2 时, 颗粒尺寸为0.5~1 μm , 颗粒形貌主要为小块状或粒状, 当超声功率大于 0.82 kW/cm^2 时, 颗粒数量随超声功率增加而急剧减少。高能超声作用下 $Al_3Ti/6070$ 复合材料的最佳制备工艺为: 超声强度 $0.66\text{--}0.82\text{ kW/cm}^2$, 超声作用时间3 min。

关键字: 铝基复合材料; Al_3Ti 增强颗粒; 高能超声

Effects of high intensity ultrasonic on microstructure and mechanism of in-situ $Al_3Ti/6070$ composites

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Abstract: In-situ $Al_3Ti/6070$ composites were synthesized by direct melt reaction method under high intensity ultrasonic field in $Al-K_2TiF_6$ system. The effects of high intensity ultrasonic on the reinforced particles in $Al_3Ti/6070$ composites with different parameters such as ultrasonic radiation time and ultrasonic intensity were investigated by XRD, SEM and EDS. The model of particle motion was established under the high intensity ultrasonic and the mechanism was discussed. The results show that the sizes of the reinforced particles decrease along with ultrasonic radiation time and then increase under a certain

ultrasonic intensity (0.66 kW/cm^2). When the ultrasonic radiation time is 3 min, the smallest size is obtained. The sizes are in range of $1\text{--}2 \text{ }\mu\text{m}$. The morphology of reinforced particles is small blocky or short rod-like. The amount of reinforced particles is decreased sharply with the increase of ultrasonic radiation time when the ultrasonic radiation time is longer than 3 min. Furthermore, the sizes of reinforced particle are decreased along with the increase of ultrasonic intensity when the ultrasonic radiation time is fixed at 3 min. When the ultrasonic intensity is up to 0.82 kW/cm^2 , the main morphology of reinforced particles is small blocky or granular, and the sizes of the particles are in range of $0.5\text{--}1 \text{ }\mu\text{m}$. But the amount of particles is decreased sharply when the ultrasonic intensity is more than 0.82 kW/cm^2 . The most suitable parameters for fabricating $\text{Al}_3\text{Ti}/6070$ composites under the high intensity ultrasonic field are: the ultrasonic intensity is in range of $0.66\text{--}0.82 \text{ kW/cm}^2$ and ultrasonic radiation period is 3 min.

Key words: aluminum matrix composites; Al_3Ti reinforced particle; high intensity ultrasonic

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