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超声化学原位合成($Al_3Zr+ZrB_2$)/A356复合材料的力学行为

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摘 要： 利用超声化学熔体原位反应技术合成颗粒增强($Al_3Zr+ZrB_2$)/A356复合材料，通过SEM原位拉伸实验及其断裂表面研究分析复合材料的断裂行为。结果表明，复合材料的抗拉强度、屈服强度和伸长率分别达到403.61 MPa、343.98 MPa和8.9%，较未施加超声作用的复合材料分别提高16.09%、12.9%和32.83%；复合材料的室温拉伸断口SEM形貌表现出明显的韧窝断裂特征，为塑性断裂。裂纹的萌生机制主要有基体在滑移过程中的位错作用机制、内生Al_3Zr和ZrB_2颗粒脱落或破碎形成的空穴成核机制和基体缺陷诱发机制；由于内生增强颗粒微观分布上的不均匀性，当主裂纹扩展前方遇到颗粒密集区时，其扩展方向偏向颗粒贫化区，绕过颗粒密集区，并沿颗粒富集区与贫化区的界面向前扩展、延伸，形成宏观裂纹。

关键字： 复合材料；超声化学；原位拉伸；力学行为

Mechanical behaviors of ($Al_3Zr+ZrB_2$)/A356 composites synthesized via in situ ultrasonic chemistry reactions

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Abstract: The particulates reinforcement ($Al_3Zr+ZrB_2$)/A356 composites were synthesized via ultrasonic chemistry melt in situ reactions, and the fracture behaviors were investigated by SEM in situ tensile observations and fracture surface characterizations. The results indicate that the tensile strength, yield strength and the elongation reach 403.61 MPa, 343.98 MPa and 8.9%, increase by 16.09%, 12.9% and 32.83% than those without ultrasonic assistance, respectively. The obvious dimple-crack characters on the SEM fracture surface of the composites were observed, and the fracture mechanism is plastic fracture. The crack initiation mechanisms are mainly the matrix dislocation actions mechanism during sliding, cavity formation mechanism due to the in situ Al_3Zr and ZrB_2 particle sloughing or bursting and the matrix defect induction mechanism. The crack growth is selective because of the non-uniform micro-distribution of the in situ particles. When the growing main cracks

are faced to the particle-rich area, the growing direction is deflected to the particle-poor area, the cracks grow along the interface of the particle-rich area and the particle-poor area, and the macro-cracks are formed.

Key words: composites; ultrasonic chemistry; in situ tension; mechanical behavior

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