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機能材料工学専攻	学籍番号	957252
申請者氏名	姚　強	

指導教官氏名	小林　俊郎　教授 戸田　裕之　助教授

論　文　要　旨(博士)

論文題目	Fracture Toughness and Fatigue Behavior of Aluminum-Silicon Casting Alloys (アルミニウムーシリコン合金鋳物の破壊靭性および疲労挙動)

Recently, cast and forging method where near-net shape cast metal is forged has been paid special attention, because it can substantially decrease cost and increase mechanical properties of casting alloys. However, in this case, it is important to evaluate the effect of this method on tensile and fracture toughness properties from the view of materials assuarance. On the other hand, aluminum die casting alloys and Al-7%Si system casting alloys have been widely used as machine structural components in the automotive industry. However, these alloys include many casting defects that have harmful effect on mechanical properties, especially in die casting alloys. Moreover, it is important to evaluate the fatigue and fatigue behavior of these alloys.

In chapter 1, the introduction to aluminum casting alloys is described.

In chapter 2, fracture toughness properties of three typical aluminum casting alloys were evaluated in comparison with cast and forged alloys. Cast and forging alloys showed increased elongation and fracture toughness with increase of forging ratio. Mechanisms of the increased fracture toughness are considered that the forging decreases and diminishes the size of casting defects with forging ratio.

In chapter 3, S-N_f curves and fatigue crack propagation characteristics of a eutectic and two kinds of hypereutectic Al-Si-Cu die casting alloys were investigated. Material containing casting defect shows a significant reduction in fatigue life. Crack is initiated from the casting defects and most of the fatigue life is spent in the fatigue crack growth region. In high Si content alloys, primary Si also becomes a fatigue crack initiation site. It is also shown that fatigue strength is insensitive to the ageing treatment. On the other hand, relationship between fatigue crack propagation characteristic and microstructure have been discussed.

In chapter 4, firstly, the relationship between microstructure and cooling rate and grain refinement in Al-7%Si casting alloy was studied, the secondly the relationship between tensile properties and microstructure was investigated. Fatigue and fatigue crack propagation characteristics of six hypoeutectic casting alloys were evaluated. The cyclic deformation curves of these alloys indicated that plastic deformation increases with decrease of the cooling rate or no refined structure, i.e. fatigue crack initiated easily in low cooling rate or no refined structure. In addition, damage mechanisms in these alloys were studied qualitatively and quantitatively by in-situ tensile test in a scanning electron microscope. Damage initiation mechanisms were found to be the fracture of eutectic Si particles.

Finally, the summary for this research and recommendations for the future are proposed.