論　文　の　要　旨

題　目　Development of Both Al-Mn and Al-Si System Alloys for a Sustainable Society, and Their As-cast Applicability

(持続可能な社会を実現する Al-Mn 系、Al-Si 系両合金の開発、およびそれらの鋳放し使用可能性)

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With the rapid development of the industry and the increasing attention to environmental issues, the research of design and improve the properties of aluminum alloys for low-cost and improve the proportion of aluminum alloys used in lightweight materials is imminent. Focusing on Al-1.5Mn-based and Al-9Si-based alloys, which are widely used as automotive body parts, the alloys have been tested and characterized for their mechanical properties, considering that there is a unified viewpoint even if the alloys are different in series. And a quantitative method for predicting the mechanical properties of Al-1.5Mn-based and Al-9Si-based alloys was proposed on the basis of the ΔMk parameter.

This thesis consists of 6 chapters. The main content of each chapter is briefly summarized as follows.

In chapter 1, the urgency of environment protection was revied, and hance, in order to solve the corresponding problem, improving the proportion of aluminum alloys which were important lightweight material for the development of transportation sectors is the most effective method. And alloy design method was discussed. The research objectives of this doctoral dissertation are also described.

In chapter 2 describes the Al-1.5Mn-based and 1.0 and 3.3Si addition alloys. The Si addition or increment in the base alloy showed strengthened tensile behavior of the 0.2% proof stress ($\sigma_{0.2}$) of 67 MPa and ultimate tensile strength (σ_{UTS}) of 160 MPa, although there was reduced in fracture strain (ε_f) to 9%. The increase and decrease in flow stress and strain, respectively, resulted from the increment in degree of solid solution strengthening by the increase of ΔMk of the alloys. It considered that the trend of change in the lattice constant, $\sigma_{0.2}$, work hardening amount and dislocation density was predominantly consistent with that in the ΔMk_α showing the indication of solid solution hardening level of the α-Al phase.

In chapter 3&4 describes Al-9Si-based alloys with 0.2Mo+0.2Zr, 0.2Ti and 0.2V addition. The microstructure with finer SDAS values of 33.6μm and eutectic regions of a larger volume of 72.2% was obtained by 0.2Mo+0.2Zr addition. The 0.2Mo+0.2Zr addition alloy showed improvement in both σ_{UTS} (160MPa) and ε_f (7.1%) at the as-cast condition, compared with those (145 MPa, 6.1%) of the base alloy because of solid solution strengthening and microstructure control. The increase in the strength of the as-cast alloy was attributed to the degree of solid solution strengthening of the continuous α-Al phase. Furthermore, the increase in ductility was attributed to the degree of segregation of solid solution element concentrations in the α-Al phase.

In chapter 5 The addition of Si to Al-1.5Mn and the addition of Mo+Zr to Al-9Si increased the strength of the alloy by 43.7% and 8.9%, respectively. The Al-1.5Mn, 1.0Si, 3.3Si, 0.8Mg, 2.4Mg and Al-9Si, Mo+Zr alloys show a linear relationship between the dislocation density, flow stress under the same plastic strain rate in each alloy increased with increasing of ΔMk value of the α-Al phase, regardless of alloy series and additive elements.

The results from above chapters were summarized in Chapter 6.