Institute of Light Metals (ILM) Joint Usage/Research Grant Report in FY 2024

2025/05/12

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| Principal investigator | | Affiliation | University of Toyama | | |
| Job title | Professor | | |
| Name | Kenji Matsuda | | |
| Collaborated researcher of ILM | | Affiliation | SINTEF | | |
| Job title | Researcher | | |
| Name | Calin D Marioara | | |
| Title of the joint research | | Age-hardening in Al-Zn-Mg (-Cu) alloys with low Zn / Mg ratio | | | |
| Joint research Program  ※check the box | | ※　Program for Joint Usage / Research Centers (JURC)  ✓　Program for International JURC  □　Program for providing samples and materials  □　Program for using ILM facilities for sample analysis and characterization | | | □ Focused themes  ✓ Transportation  □ Biomaterials  □ Bridge/building materials  □ Kink strengthening  □　Independent research theme |
| Name of joint usage apparatus | | HRTEM（EM-002B, Topcon, University of Toyama）、STEM（Talos 200X G2, Thermo Fisher Scientific , ARC in University of Toyama） | | | |
| Total amount of grant | Travel expense（　　　　　　　　　　　JPY） | | | Consumable Fee（　　　　5,800　　　JPY） | |
| **Research Results**　**※Please describe following three items briefly.**  **Main Results and Discussion**   * **Cu Addition Effect:** The Cu-containing alloys exhibited significantly accelerated initial hardening and achieved ~15–20 HV higher peak hardness than Cu-free alloys. * **Precipitate Morphology:** In Cu-free alloys, coarse T-phase precipitates were observed during aging. In contrast, Cu-containing alloys showed a fine distribution of both T and η′ phases, which enhanced precipitation hardening and retarded overaging. * **Thermal Analysis:** DSC revealed that the precipitation peaks shifted to higher temperatures with Cu addition, indicating improved thermal stability. * **Overaging Resistance:** The lower Zn/Mg ratio led to a slower degradation of hardness during overaging, likely due to the stable distribution of the T phase.   **Conclusion** Cu addition to low Zn/Mg ratio Al-Zn-Mg alloys refines precipitate morphology, enhances mechanical strength, and improves resistance to overaging. These findings suggest that such alloys can be promising lightweight and thermally stable materials for future applications.  【Future Prospects】  The present study has revealed that Cu addition to low Zn/Mg ratio Al-Zn-Mg alloys significantly influences the precipitation sequence and improves both mechanical strength and thermal stability. Building upon these findings, several avenues for future research can be identified.  First, systematic investigations into the effect of varying Cu concentrations are essential to optimize the balance between η′ and T phase formation. Understanding the compositional thresholds that promote specific phase stability will enable more precise alloy design tailored to targeted applications.  Second, long-term thermal exposure will be conducted to evaluate the structural and mechanical stability of the microstructure under service-like conditions. These studies will help validate the alloy's potential for high-temperature applications such as automotive powertrain or aerospace structural components.  Third, advanced characterization techniques—such as atomic-resolution STEM, and HR-TEM will be employed to clarify the atomic-scale interface structures and solute partitioning behavior between matrix and precipitates.  Finally, integration of these microstructural insights into predictive models (e.g., phase-field or CALPHAD-based simulations) will contribute to a robust alloy design framework, accelerating the development of lightweight, high-performance materials for next-generation structural applications.  【Concrete results】  　●Publication  ●Conference presentation : Enhanced Anode Performance for Aluminum-Air Batteries by Severe Plastic Deformation Processes” by Asst.Prof.Dr.Chaiyasit BANJONGPRASERT  at the 4th ILM International Seminar and the 9th CAMRIC Forum (Center for Advanced Materials Research and International Collaboration), held online by the University of Toyama during the 24th Light Metals International Workshop by JILM  　●International conference presentation  ●Invited lecture : A lecture to graduate students as part of the Global Engineering Lecture Series  On 9 December 2025 at University of Toyama  　●Award  　●Acquired external funds 　　etc. | | | | | |
| **Notes**  ・Please use the form and submit to the URL provided in the email by Friday, May 16, 2025.  ・The joint research report will be published in the ILM joint research report (annual report) and will be available on our website. Therefore, please prepare the contents for public release accordingly.  ・Please add pages, if needed. | | | | | |