Institute of Light Metals (ILM) Joint Usage/Research Grant Report in FY 2025

2026/06/3

Principal investigator	Affiliation	The Sirindhorn International Thai-German Graduate School of Engineering, King Mongkut's University of Technology North Bangkok, Thailand
	Job title	Associate Professor
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Collaborated researcher of ILM	Affiliation	ARC, University of Toyama
	Job title	Professor
	Name	Tomomi Shiratori
Title of the joint research	Correlation between residual stresses and tribological properties: Impact on the lifespan of AlCrN coatings in aluminum extrusion die applications	
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	Extrusion testing apparatus, Hydraulic press, Sputtering machine, In-line wear depth observation, EPMA, Raman spectroscopy, Laser texturing machine and other facilities	

Total amount of grant	Travel expense (240,000JPY)	Consumable Fee (60,000JPY)

Research Results ※Please describe following three items briefly.

【The major results】 The goal of this study is to investigate how residual stresses affect the tribological performance of thin-film coatings in order to improve their service life and overall performance. The tribological properties of the coatings have been examined using a tribometer, and their adhesion energy has been determined by scratch testing, coupled with contact angle measurements to estimate residual stress levels. The residual stress magnitude of the PVD coating was computed from the scratch test and was consistent with the findings obtained from XRD. Moreover, this work aims to design a new coating system, called the Cr_3C_2-Ti-DLC-coated SKD61 steel, which is successfully produced using the dual magnetron sputtering technique. The FSW-coated tool effectively reduced the friction heat generated by the friction stir welding (FSW) process, as evidenced by the tool testing apparatus, and exhibited a minimal wear rate. Furthermore, the prediction of coating tribological properties was introduced using machine learning and artificial intelligence approaches.

【Future Prospects】 For residual stress evaluation, future work may emphasize various types of thin-film coatings to ensure the technique is reliable. The proposed coating will be applied to the actual aluminum extrusion die, thereby linking the residual stress retained before and after use. Furthermore, future research could explore DLC's multilayer and variable interlayer coatings, which may further enhance tool performance and wear resistance of aluminum forming applications.

【Concrete results】

<Publication>

(1) "Residual Stress Estimation of Thin Film Coatings using Scratch Tests" (Manuscript preparation)

(2) S. Mandol and P. Nunthavarawong. A Critical Review of Tribological Property Prediction of Thermally Sprayed Coatings Using Machine Learning Approaches. J Bio Tribo Corros 12, 1 (2026)

(3) Abhilash, P. Nunthavarawong, et. al. Performance of Cr_3C_2-Ti-DLC Coated Tools in Dissimilar Friction Stir Welding. Surf Eng (Under review)

<International Conference>

Notes

・Please use the form and submit to ILM office (mrc@kumamoto-u.ac.jp) 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.