マテリアル先端リサーチインフラ利用報告書
ARIM User's Report

【Release：2025.06.10】　【Update：2025.04.18】

課題データ / Project Data

課題番号 Project Issue Number	24NU0042
利用課題名 Title	金属３Ｄプリンタ積層造形体の構造解析
利用した実施機関 Support Institute	名古屋大学 / Nagoya Univ.
機関外・機関内の利用 External or Internal Use	内部利用（ARIM事業参画者以外）/Internal Use (by non ARIM members)
ARIM半導体基盤PF 関連課題 Related to ARIM-SETI	指定なし / No Designation
横断技術領域 Cross-Technology Area	計測・分析/Advanced Characterization
重要技術領域 Important Technology Area	高度なデバイス機能の発現を可能とするマテリアル/Materials allowing high-level device functions to be performed
キーワード Keywords	セラミックスデバイス/ Ceramic device,センサ/ Sensor,電子顕微鏡/ Electronic microscope,電子回折/ Electron diffraction

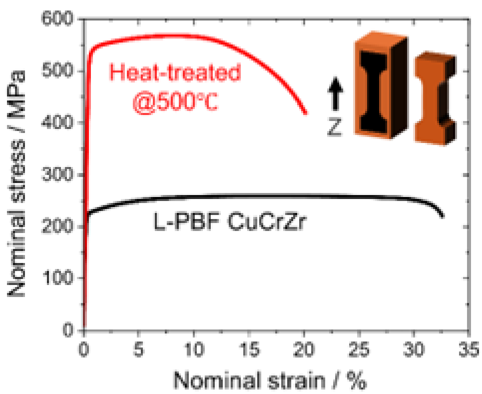
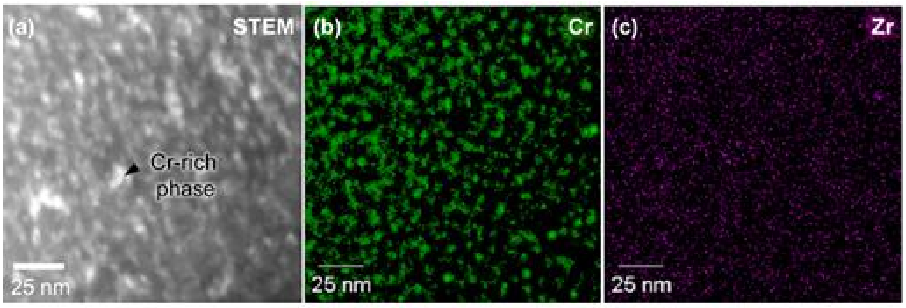
利用者と利用形態 / User and Support Type

利用者名（課題申請者） User Name (Project Applicant)	高田 尚記
所属名 Affiliation	名古屋大学 大学院工学研究科
共同利用者氏名 Names of Collaborators Excluding Supporters in the Hub and Spoke Institutes	キムダソム,徐一璠,大谷祐貴
ARIM実施機関支援担当者 Names of Supporters in the Hub and Spoke Institutes	
利用形態 Support Type	機器利用/Equipment Utilization

利用した主な設備 / Equipment Used in This Project

利用した主な設備 Equipment ID & Name	NU-103：高分解能透過電子顕微鏡システム NU-105：バイオ/無機材料用高速FIB-SEMシステム

報告書データ / Report

概要（目的・用途・実施内容） Abstract (Aim, Use Applications and Contents)	Cu-Cr-Zr (CuCrZr) alloy, which is one of the presentative precipitation hardening alloys, is a promising candidate for electric device materials and thermal management in automobiles and aerospace. It is necessary to control the morphologies/distribution of precipitates and solute content within the Cu (fcc) matrix of CuCrZr alloy, which are dominant contributors to determining the mechanical properties. Laser powder bed fusion (L-PBF) enables the manufacture of complex-shaped metallic components via a tremendously rapid solidification process, resulting in supersaturated solute Cr in L-PBF processed CuCrZr alloy. In this study, we investigated the strengthening mechanism of L-PBF-processed CuCrZr alloys via the microstructural change after heat treatment.
実験 Experimental	Rectangular alloy samples (15~60 × 60 × 70 mm^3) were fabricated using the gas-atomized CuCrZr alloy powder and SLM280PS machine (SLM Solutions GmbH, Germany) under a laser scan speed of 0.6 m/s and laser power of 400 W. The applied laser-scanning hatch distance, powder-bed thickness, and beam focus size were 0.07 mm, 0.03 mm, and 0.08 mm, respectively. The L-PBF sample was heat-treated at 500 °C for 1 h. Tensile tests were conducted at room temperature. The microstructure was characterized via transmission electron microscope (TEM, JEOL JEM-2100F/HK, Japan).
結果と考察 Results and Discussion	The ultimate strength of the L-PBF CuCrZr alloy (250 MPa) was 2.3 times increased after heat treatment at 500 °C shown in Fig. 1. It was found that the fine Cr-rich phase is distributed within the Cu matrix shown in Fig. 2. Such Cr-rich phase was precipitated from the Cr saturated in the Cu matrix during the heat-treatment. That is, supersaturated Cr in the Cu matrix due to the rapid cooling rate of the L-PBF process contributed to the significant strengthening after heat treatment.
図・表・数式 1 Figures, Tables and Equations 1	 Fig. 1. Nominal stress-strain curves of L-PBF and subsequently heat-treated CuCrZr alloys.
図・表・数式 2 Figures, Tables and Equations 2	 Fig. 2. STEM image and corresponding EDS elemental maps of L-PBF CuCrZr alloy sample heat-treated at 500 °C for 1h.

その他・特記事項（参考文献・謝辞等） Remarks(References and Acknowledgements)	The technical support of TEM operations by K. Higuchi and Y. Yamamoto was gratefully acknowledged.

成果発表・成果利用 / Publication and Patents

DOI（論文・プロシーディング）[1] DOI (Publication and Proceedings)	Dasom Kim, Anomalous temperature-dependent strength of copper alloy manufactured by laser-beam powder bed fusion, *Additive Manufacturing Letters*, **11**, 100236(2024). DOI: https://doi.org/10.1016/j.addlet.2024.100236
口頭発表、ポスター発表および、その他の論文[1] Oral Presentations etc.	Dasom Kim, Naoki Takata, Junji Umeda, Toshihiko Shimizu, Makoto Kobashi, Oral Presentation, Unique High-Temperature Mechanical Behavior of CuCrZr Alloy Additive-Manufactured by Laser Powder Bed Fusion, 2024 MRS Fall Meeting & Exhibit (Boston), Dec. 2024.
口頭発表、ポスター発表および、その他の論文[2] Oral Presentations etc.	Kim Dasom、高田 尚記、梅田 隼史、清水 稔彦、小橋 眞，レーザー粉末床溶融結合法によるCuCrZr合金造形体の組織と強度に及ぼす熱処理の影響，ポスター発表，日本金属学会 2025年春期(第176回）講演大会（東京都立大学），2025年3月.
特許出願件数 Number of Patent Applications	0件
特許登録件数 Number of Registered Patents	0件