Institute of Light Metals (ILM) Joint Usage/Research Grant Report in FY 2023

2024/05/28

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| Principal investigator | | Affiliation | Instituto Tecnológico de Costa Rica | | |
| Job title | Associate Professor | | |
| Name | Jorge M. Cubero-Sesin | | |
| Collaborated researchers of ILM | | Affiliation | MRC, Kumamoto University | | |
| Job title | Professors | | |
| Name | Takanori Kiguchi / Zenji Horita | | |
| Title of the joint research | | Hexagonal metallic materials for orthopedic prostheses | | | |
| 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 | | SEM, EBSD, Hardness tester, XRD | | | |
| Total amount of grant 300 000JPY | Travel expense（298359 JPY） | | | Consumable Fee（1641 JPY） | |
| **Research Results**　**※Please describe the following three items briefly.**  【The major results】  In this research, pure titanium was processed in the form of 10 mm discs by High-Pressure Torsion (HPT).  A heat treatment at 800°C for one hour was conducted to compare samples with and without prior heat treatment before undergoing the HPT process. Following HPT, the annealed samples were exposed to 130°C for 5 and 20 minutes to examine the temperature effects on the omega phase.  The study also investigated the influence of pressure on the formation of the omega phase in titanium and its impact on mechanical properties. Pressures of 2, 4, 5, 5.25, 5.5, and 6 GPa were used for the HPT process at 1 rpm for 1 revolution. For the High-Pressure Sliding (HPS) process, pressures of 2, 5, and 6 GPa were applied. For the HPT samples, it was found that the fraction of the omega phase is proportional to the pressure used during the process, with no omega phase detected in samples processed at 2 and 4 GPa. For the HPS samples, the omega phase was detected only for the sample processed under 6 GPa.  Microstructural characterization and mechanical properties analysis were performed using Electron Backscatter Diffraction (EBSD), X-ray Diffraction (XRD), tensile testing, and Vickers microhardness testing.  For the HPT samples, there were no significant differences in microhardness and tensile test values between As-HPT samples and samples annealed at 130°C for 5 and 20 min. Among the HPT-processed samples, the one processed under 5 GPa displayed the best balance between tensile strength and elongation. It was observed that after 1.5 revolutions, the sample still exhibited elongation, but increasing the revolutions further significantly reduced elongation, leading to brittle failure.  HPS samples were analyzed both parallel and perpendicular to the induced deformation, revealing that parallel analysis exhibited higher tensile strength and greater elongation than the perpendicular analysis.  【Future Prospects】  It is intended to perform TEM analysis on the samples that presented optimal mechanical properties to determine the grain size of the Ti samples. Analyze the behavior of the phases during the tensile test. For this, it is possible to perform hardness measurements on the tip of the tensile samples and XRD analysis. The aim is to understand the behavior of the omega phase under various conditions.  【Concrete results】  (1) This study will be presented at an international conference in 2024. | | | | | |
| **Notes**  ・Please use the form and submit to ILM office (mrc@kumamoto-u.ac.jp) by Friday, April 28, 2023.  ・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. | | | | | |