令和 3 年度

在 外 研 究 員 報 告 書

所　　属	理学部　　機械工学科		
職　　名	教授	氏　　名	アブラハ ペトロス
調査研究題目	鋼製手術器具の強化とその応用に関する研究		
研究先国	アメリカ	研究機関	カリフォルニア大学（デービス校）
期間（西暦年）	令和3 年 9月 1日 ～ 令和 4年 8月 31日		
研究員の種類	長期支給研究員		

Summary: I am pleased to report that despite the difficult situation due to the circumstances related to the COVID-19 pandemic, I had a successful sabbatical leave. In general, work engagement during the sabbatical period was hybrid, evenly divided into in-person and remote work. During my stay, I identified and strengthened the selected surgical tool, bone biopsy needles, to more than two times that of the untreated ones. I also accomplished several other goals. These include: Publishing a journal paper, presenting a paper at an international conference, attending a medical devices trade show, securing an award for a research grant application, and Meijo – UC Berkeley Entrepreneurship Workshop. I have organized the report of my accomplishments as follows.

Academic Research: My academic research work focused on strengthening the sharp cutting edges of surgical tools using a patented proprietary technology that I developed. Soon after my arrival, I began to sort out the specific surgical-tool appropriate for our experimental work. Upon several thorough discussions with my partners, a bone biopsy needle was selected as the experimental surgical tool. Bone biopsy needles are stainless steel tools used by surgeons for drilling the hard bone surface that is performed to confirm the diagnosis of a bone abnormality. The experimental work on the optimal plasma nitriding conditions that may produce strengthened bone biopsy needles without changing the original surface conditions was the first task done. After a lengthy optimization case study, the driving conditions for the various nitriding parameters were determined. In the subsequent nitriding processes, we were capable of obtaining harder cutting edges. The results of our experiments show that the bone biopsy needles were strengthened to more than two times the pre-treatment hardness while maintaining the surface conditions (color, roughness, and reflectivity). Besides, the design of the tip of the bone biopsy needles for a durable and ridged construction proceeded using the Finite Element Method. The optimal design for the tip of the bone biopsy needles was based on a review of the FEM design variations that highlighted durability and ease of use by specific surgeons. The final output, however, is short of planned preliminary clinical trials because of restrictions in place due to COVID situations.

Educational Lessons: One of the lessons I learned that should merit adoption is the Engineering Design Showcase for graduating classes at UC Davis. In this showcase, students complete a capstone project and share their work with the public. Selected experts from the public then serve as evaluators who provide expert feedback to student teams on their exhibits. The showcase boosts students' motivation to a great extent. I think it would be beneficial to adopt the idea at Meijo University.

Journal Publications (July 2022): I published an article in the Japanese Society of Tribologists (JST). The paper is entitled "Sliding properties of hydrogenated diamond-like carbon coatings on CFRP surfaces," Tribologist, Vol.67 No.7 (2022) PP 507-513

Conference Presentation (May 2022): I presented my paper at the 48th International Conference on Metallurgical Coatings and Thin Films (ICMCTF 2022), San Diego, USA. The research paper was on enhanced wear and corrosion properties of stainless steel by electron-induced plasma nitriding.

Trade Show (December 2021): I attended the Medical Design & Manufacturing (MD&M 2021) trade show held at the Javits Convention Center, in New York. I had detailed discussions about bone biopsy needles with several medical device companies that displayed and demonstrated their latest products. During the discussions, the engineers acknowledged the need for enhanced cutting-edge tips.

Secured Grant (2022): I secured a grant from Nitto Science Foundation. The proposed research project is "Improving Mechanical Properties of Stainless Steel Using Plasma Nitriding." The award is a total sum of 1,000,000 Japanese Yen.

Meijo – UC Berkeley (Entrepreneurship Workshop (2022): I organized a successful workshop for Meijo University students in the Challenge support program to collaborate with UC Berkeley students on an entrepreneurship workshop. The workshop was held between 2/21-2/25, live via Zoom. The participants of the workshop were 22 students from Meijo University and 14 students from UC Berkeley.