






BoneDrill

Development and Friction Characterization of Biomodels of Bones

MAIN PARTICIPANTS

				
Makoto OHTA^{a, b}	Vincent FRIDRICI^c	Yuta MURAMOTO^{a, c}	Gaëtan BOUVARD^c	Philippe KAPSA^c
^a Institute of Fluid Science, Tohoku University, Sendai, Japan				
^b ELYTMaX, UMI 3757, CNRS, Université de Lyon, Tohoku University, Sendai, Japan				
^c LTDS, UMR 5513, CNRS, Ecole Centrale de Lyon, Ecully, France				

Contact: makoto.ohata@tohoku.ac.jp, vincent.fridrici@ec-lyon.fr

OVERVIEW

Starting year: 2011

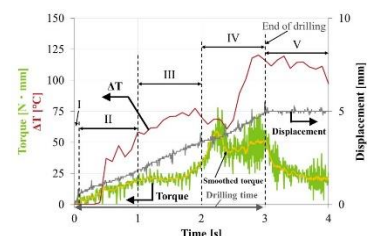
Current researchers (permanent/non-permanent): 5 person-month/year

Positioning <i>(Multiple selection allowed – total 100%)</i>	Transportation	Energy	Eng. for Health	Include partner from <input checked="" type="checkbox"/> Outside ELYT <input type="checkbox"/> Industry
				Main funding source(s) <input checked="" type="checkbox"/> Public project(s) <input type="checkbox"/> Industrial <input checked="" type="checkbox"/> Own resources
				IFS CRP/LyC project? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
				For main projects: Agency / year / name of project (<i>up to 3, past projects in gray</i>) • Labex MANUTECH-SISE / 2017-2020 / BoneDrill project
Materials and structure design			75 %	Estimated annual budget: 5 k€
Surfaces and interfaces			25 %	
Simulation and modeling				
Other:				

Highlights & Outstanding achievements

- Double degree Ph.D. defenses of Yuta MURAMOTO in Tohoku University and in Ecole Centrale de Lyon.
- Development of engineered materials with controlled tribological properties in drilling for application in dentistry (training of students and surgeons, standardization, characterization for development of tools and prostheses).
- Development of tribological test methodology for determining friction properties during drilling of bones and biomodels.
- Yuta went back to Japan just before lockdown!!! and could start working for an implant company in Japan.

Illustration



PROJECT DESCRIPTION

Background (10 lines max; Calibri 11)

The objective of this project is to develop bones biomodels with drilling characteristics similar to the ones of natural bones. These biomodels could be used for the training of doctors or development / evaluation of medical devices. Important characteristics are mechanical properties (hardness, elasticity modulus) and friction between the biomodel and a drill, in order to give to the doctors the same feeling as with natural bones for the drilling of the bones.

In the last years, this project was supported by the works of Yuta Muramoto, first as a TU master student (with a 1-year stay at ECL) and then as a double degree PhD student between TU and ECL, with final defense in the beginning of 2020.

Key scientific question (2 lines max; Calibri 11)

Characterizing friction properties during drilling

Developing materials with similar properties in drilling than bone.

Research method (8 lines max; Calibri 11)

Different composite materials, based on PMMA, have been developed and characterized (in mechanical tests and drilling tests), in order to understand the effects of different types of additives on hardness, elastic modulus, thrust force, maximum friction torque, drilling speed... This project focuses on the relationships between these parameters and the materials' microstructure, by taking into account temperature, lubrication and chips shape during drilling. Validation of the newly developed composites is performed by drilling tests realized by surgeons to rank developed composites, already existing bone biomodels and natural bones, in terms of feeling during drilling.

Research students involved

Ph.D. candidates (years, institution):

- Yuta Muramoto (2017-2020, Tohoku University – Ecole Centrale de Lyon)

Master/Bachelor students (years):

- Yuta Muramoto (2014-2017, Tohoku University with 1 year-stay at ECL)

Visits and stays (from 2017)

FR to JP (date, duration):

- V. Fridrici (September 2019, 1 week)
- V. Fridrici (March 2019, 4 days)
- V. Fridrici (August–September 2018, 10 days)
- V. Fridrici (November 2017, 5 days)

JP to FR (date, duration):

- M. Ohta (February 2020, 4 days)
- M. Ohta (October 2019, 4 days)
- M. Ohta (November 2018, 3 days)
- M. Ohta (October 2018, 2 weeks)
- M. Ohta (July 2018, 3 days)
- M. Ohta (February–March 2018, 5 weeks)
- M. Ohta (February 2017, 3 days)

COMMUNICATIONS AND VALORIZATION

Journal publications *(gray color for previous years)*

	Authors	Title	Journal	Vol.	pp. / ID	Year	DOI
1	Y. Muramoto, V. Fridrici, Ph. Kapsa, G. Bouvard and M. Ohta	Effects of temperature increase during surgical drilling in acrylic resin	Technology and Health Care	28(4)	369-380	2020	10.3233/THC-191870 https://content.iospress.com/articles/technology-and-health-care/thc191870

Conferences *(gray color for previous years) (from 2017)*

	Authors	Title	Conference	Date	City	Country	DOI (if applicable)
1	Y. Muramoto, V. Fridrici, M. Ohta, P. Kapsa, G. Bouvard	Tribological characterization of acrylic composite materials for bone biomodel: the effects of alumina cement on drilling haptics	Lyon Saint Etienne & Nippon Scientific Network Engineering sciences Lyon Tohoku LyonSE&N – ELyT Workshop 2020	Feb. 17-19, 2020			
2	Y. Muramoto, V. Fridrici, P. Kapsa, G. Bouvard, M. Ohta	Drilling properties of acrylic composite materials for modeling of bone drilling in dry conditions	International Tribology Conference (ITC)	Sept. 17-21, 2019			
3	Y. Muramoto, V. Fridrici, P. Kapsa, G. Bouvard, M. Ohta	The effects of additive amount of acrylic composite materials on drilling properties towards development of bone biomodels	46th Leeds-Lyon Symposium on Tribology	Sept. 2-4, 2019			
4	Y. Muramoto, G. Bouvard, V. Fridrici, P. Kapsa, M. Ohta	Drilling of PMMA-based bone biomodel: The effects of temperature elevation during drilling	8th World Congress of Biomechanics	July 8-12, 2018	Dublin	Ireland	
5	Y. Muramoto, G. Bouvard, M. Ohta, V. Fridrici, P. Kapsa	Fabrication, Observation and Tribological Characterization of Acrylic Composite Materials for Bone Biomodel for Surgical Drilling	30èmes Journées Internationales Francophones de Tribologie (JIFT2018)	May 16-18, 2018	Sophia Antipolis	France	

6	Y. Muramoto, G. Bouvard, V. Fridrici, Ph. Kapsa, F. Lundell, M. Ohta	Research of high speed contact with medical devices	International Conference on Flow Dynamics - ICFD 2017	November 1-3, 2017	Sendai	Japan	
7	Y. Muramoto, V. Fridrici, P. Kapsa, G. Bouvard, F. Lundell, M. Ohta	Drilling of PMMA-based bone biomodel: effect of additives	World Tribology Congress 2017	September 17-22, 2017	Beijing	China	

Patents *(gray color for previous years)*

Inventors	Title	PCT #	Year
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Others *(gray color for previous years)*

Tohoku University, President award (Yuta Muramoto)