Research, Educational and Other Activities at IMID

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Presentation – IMID Seminar
3rd December 2014, FME BUT, Czech Republic
Contents

- Research activities
  - PhD thesis introduction
  - Experimental method
  - Internship at Kyushu University
  - Biotribology research
  - Publications

- Educational activities

- Other activities
Topic: Analysis of lubricating film formation in hip joint replacements

- Mavraki and Cann, 2011
- Fan et al., 2011
- Myant and Cann, 2013
- Vrbka et al., 2014
- Myant and Cann, 2014
**PhD thesis introduction**

**Topic:** Analysis of lubricating film formation in hip joint replacements

- Mavraki and Cann, 2011
- Fan et al., 2011
- Myant and Cann, 2013
- Vrbka et al., 2014
- Myant and Cann, 2014

- Contact lubricated by bovine serum (BS)
- Non-newtonian fluid behavior
**Topic: Analysis of lubricating film formation in hip joint replacements**

- Mavraki and Cann, 2011
- Fan et al., 2011
- Myant and Cann, 2013
- Vrbka et al., 2014
- Myant and Cann, 2014

- Real femoral head was investigated
- Significant influence of lubricant composition
Topic: Analysis of lubricating film formation in hip joint replacements

- Mavraki and Cann, 2011
- Fan et al., 2011
- Myant and Cann, 2013
- Vrbka et al., 2014
- Myant and Cann, 2014

„Inlet phase“ definition
Prediction with respect to shear thinning behavior of lubricant.
PhD thesis introduction

Topic: Analysis of lubricating film formation in hip joint replacements

- Mavraki and Cann, 2011
- Fan et al., 2011
- Myant and Cann, 2013
- Vrbka et al., 2014
- Myant and Cann, 2014

Investigation of surface wettability
Clear evidence of importance of conformity
**PhD thesis introduction**

**Topic: Analysis of lubricating film formation in hip joint replacements**

- Mavraki and Cann, 2011
- Fan et al., 2011
- Myant and Cann, 2013
- Vrbka et al., 2014
- Myant and Cann, 2014

- Protein aggregation lubrication „PAL“ definition
- Fundamental difference against EHL.
Aim of the thesis

The aim of the thesis is to describe protein film formation within artificial hip joints with emphasis on the influence of lubricant constituents.

Sub-aims

- To choose and debug measurement method
- To evaluate protein film formation
- To analyze and generalize achieved results
Experimental method

**Optical interferometry**
- Film thickness evaluation
- An insight into a contact
- Lubricant constituents distinction
- Analysis of non-reflective surfaces

**Fluorescent microscopy**

The result is the gap between surfaces

The result is the intensity of fluorescent dye
Experimental method - progress

- Film thickness analysis of lubricated compliant bodies (diploma thesis)

- Lubricant Division in EHL Contact Outlet
Methodological procedure

- Ball-on-disc model configuration – film thickness evaluation
  - CoCrMo x glass
  - CoCrMo x glass coated with Cr
  - Ceramic x glass
  - Ceramic x glass coated with Cr

- Model fluid composition
  - Usage of stained proteins (role of each protein on film formation)

- Influence of load and speed on protein film formation
Internship at Kyushu University

- Kyushu University
  - Fukuoka, Kyushu, Japan
  - ~ 2 300 Academic staff
  - ~ 20 000 Students
  - School of medicine, engineering, economics, ...
  - 7th best university in Japan (~ 90 universities in total)
Internship at Kyushu University

Analysis of lubricant composition on coefficient of friction and protein adsorption on rubbing surfaces of artificial hip joints

Pin-on-plate fiction test

Fluorescence observation + ellipsometry
Analysis of lubricant composition on coefficient of friction and protein adsorption on rubbing surfaces of artificial hip joints
PVA hydrogel research

- ~ 85% water content
- One of the anticipating material for artificial cartilage

Traction curves using MTM

Pendulum tests

ICMD 2014, Beroun (presentation)

ICoBT 2014, Toronto (presentation)
Internship at Kyushu University – concluding remarks

- Experiences about protein film formation, protein labelling process
- Participation at Joint Forum of 2nd Japan-Singapore Exchange Seminar & ICT Farm Project, Kuju, Japan
- Cooperation establishment
- English improvement
- Japanese culture, food, people, amazing experience!
Biotribology research

- Cooperation with Orthopedic clinic, University Hospital Olomouc
  - Protein labelling (application of process learnt at Kyushu University)
  - Preparation of model fluids

- Plan of experiments (first experiments conducted)

- Cooperation with Institute of Materials Science and Engineering
  - Serhii Tkachenko, Ph.D.
  - Frictional properties of Ti-Si alloys for biomedical applications


KOŠŤÁL, D.; NEČAS, D.; ŠPERKA, P.; SVOBODA, P.; KŘUPKA, I.; HARTL, M. Lubricant Division in EHL Contact Outlet. IN PREPARATION


Joint Forum of 2nd Japan-Singapore Exchange Seminar & ICT Farm Project 2013, Kuju - Presentation

ICoBT 2014, Toronto – Presentation + poster

EORS 2014, Nantes – Poster

Tribology frontiers 2014, Chicago – 2 presentations
Educational activities

- 9AJ - English for Doctoral Degree Study
- 9MOP - Methodologies of Scientific Work
- 9VPR - Research Project and its Management
- 9EHD - Elastohydrodynamics
- 9EXT - Experimental Methods in Tribology

- Doctoral exam (10/2014)
Teaching activities

Winter semester
- 5KS – Machine Design – Machine Elements
- ZKP – Team Project
- ZSY-A – Finite Element Method – ANSYS Classic
  - New educational materials in English

Summer semester
- 6KT – Machine Design – Machine Drives
- ZAW – Finite Element Method – ANSYS Workbench
Teaching activities

**Bachelor thesis supervising**
- Design of the loading mechanism for low load
- Lubricants created by nature
- Methodological guide and digitization of gear pump
- A review of hip joint replacements in terms of wear

**Diploma thesis supervising**
- Analysis of lubricated compliant contact – final year
- FEM simulation of elastohydrodynamic contact – final year
- Laser induced fluorescence for studying compliant contacts – first year
- Experimental analysis of lubricant film formation in total hip joint replacements – first year
Other activities

- Open days
- Meetings with students

- HS13457126
- HS13457060
- HS13457173

Projects

- IGA - The influence of joint fluid composition on formation of lubricating film in THA
- Specific research – Analysis of friction, wear and lubrication of joint replacements

Academic Senate member (from 11/2014)

- Member of Financial Commission
- Member of Commission for Science and Research
Other activities
Thank you for your kind attention

David Nečas