

Internship at Kyushu University

David Košťál

Department of machine design
Faculty of Mechanical Engineering
Brno University of Technology

Brno, 22.5.2019



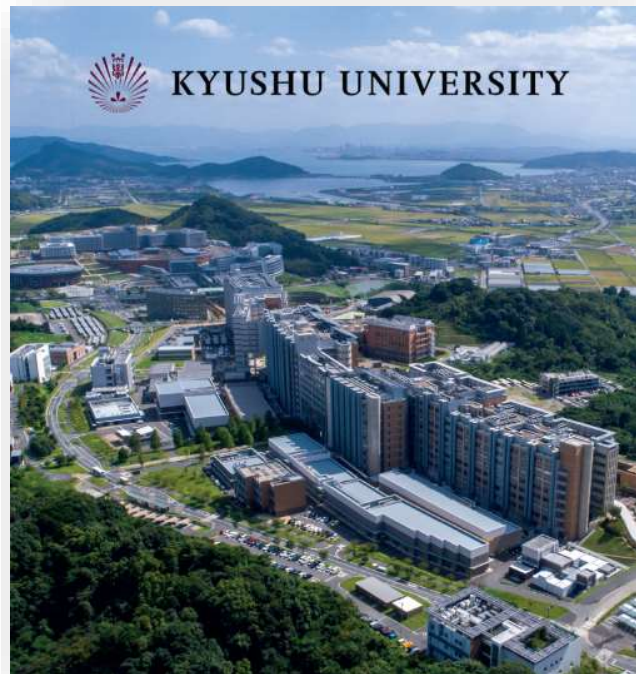
Overview

Mezinárodní mobilita výzkumníků Vysokého učení technického v Brně

CZ.02.2.69/0.0/0.0/16_027/0008371 - 3. FSI JUNIOR ZCR 10

1/10 – 31/3 (6 months)

Topic: Fluorescence methods in the grease EHL

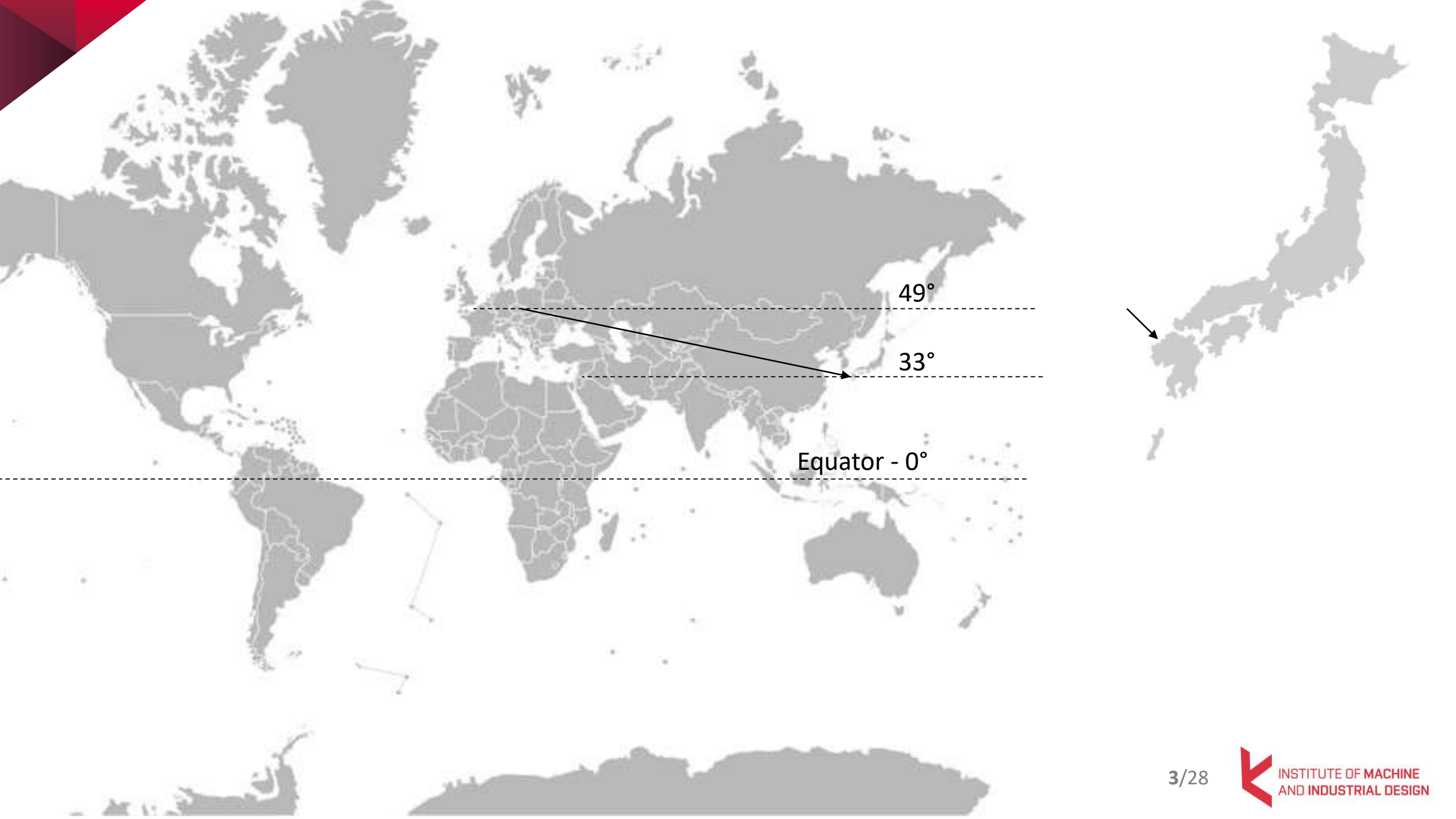


Supervisor:
Prof. Joichi Sugimura

- Professor, Dept. Mechanical Engineering, Kyushu University
- Director, Research Center for Hydrogen Industrial Use and Storage (HYDROGENIUS), Kyushu University
- Chief editor, Tribology Online, Japanese Society of Tribologists
- Chief editor, Journal of Japanese Society of Tribologists (2009)
- Associate editor: Journal of Tribology, American Society of Mechanical Engineers, Tribology International, Lubrication Science

- Application of the fluorescence to EHD in 2000





49°

33°

Equator - 0°

Japan



Area: 377 973 km²
Population: 126 m
Pop density: 334/km²
GDP (PPP): 44 550 USD (28th)
Lager price: 5.27 USD



Area: 78 866 km²
Population: 10 m
Pop density: 134/km²
GDP (PPP): 39 337 USD (35th)
Lager price: 1.12 USD

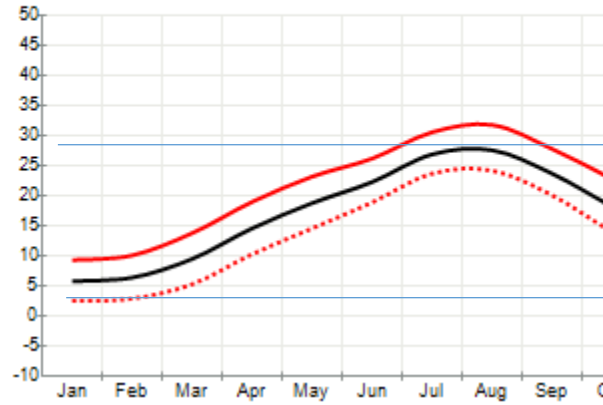


Fukuoka-shi

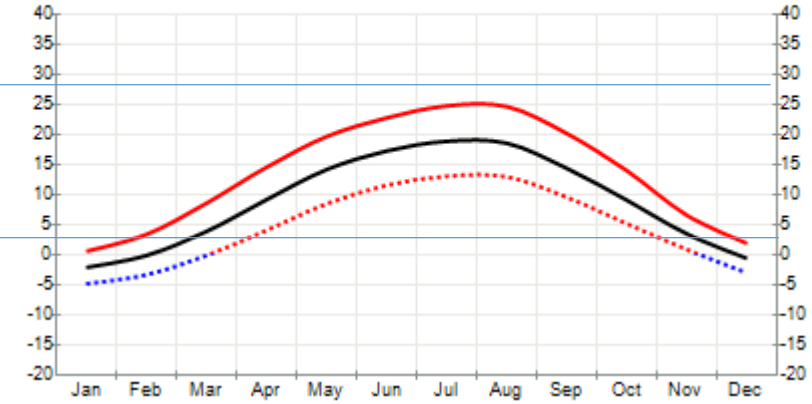
Fukuoka-shi

Capital of Fukuoka prefecture
The biggest city at Kyushu island
1.579m inhabitants (6th in Jap)

Average temperature per month



Average temperature per month

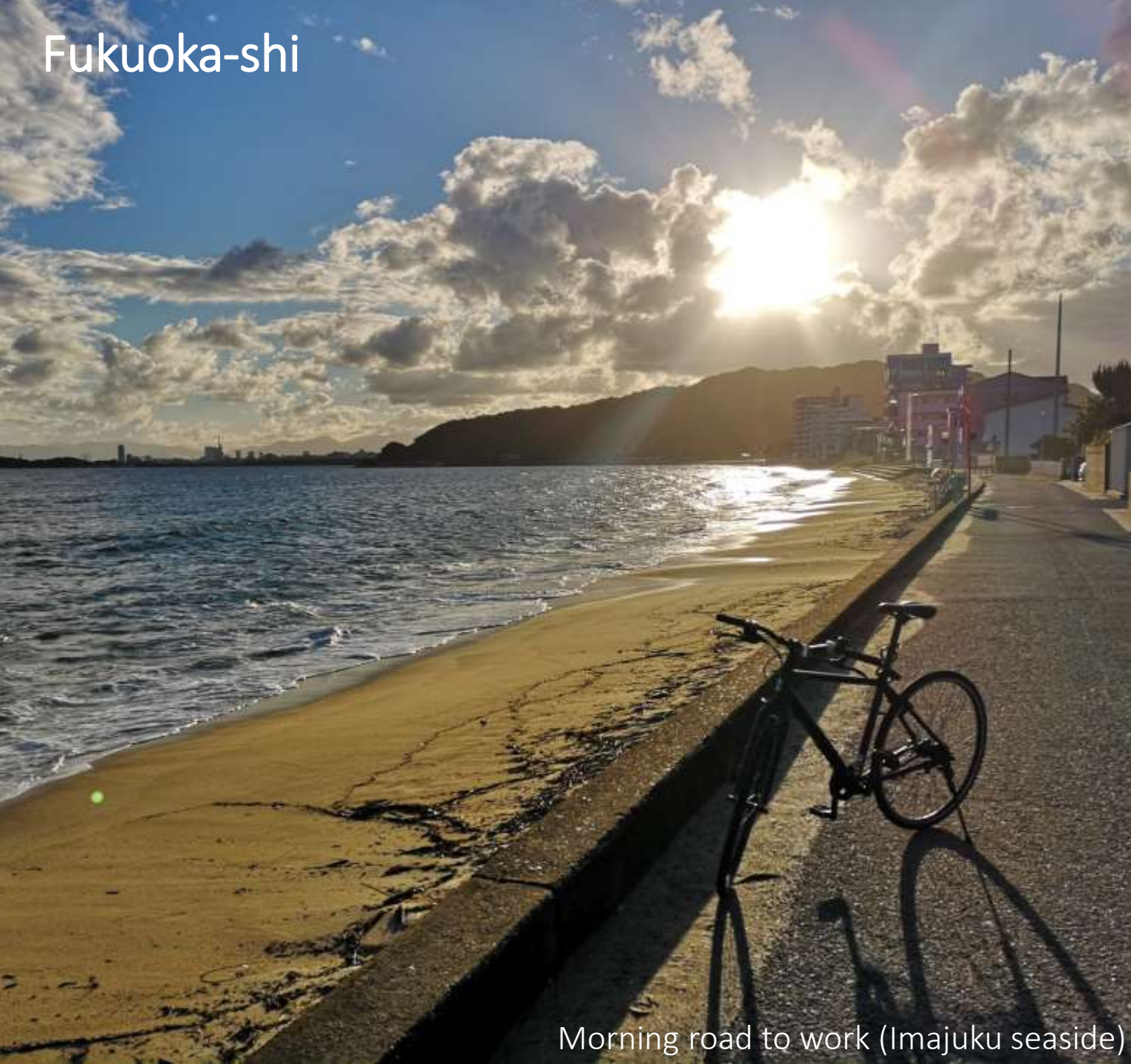


Fukuoka-shi



Fukuoka tower

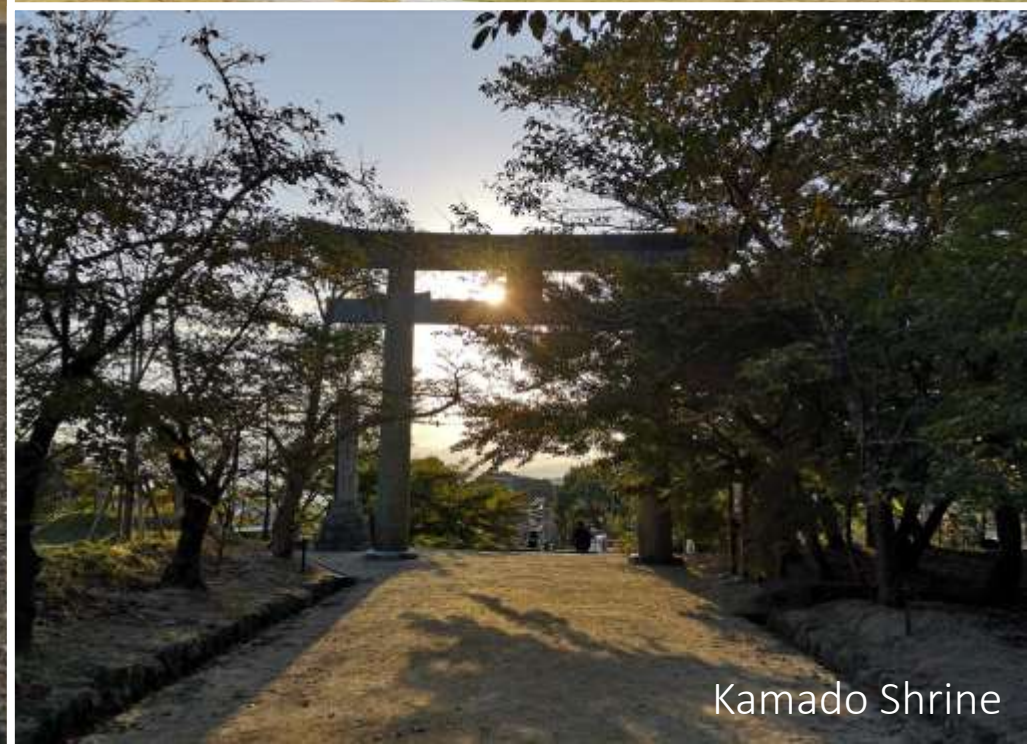
Fukuoka-shi



Morning road to work (Imajuku seaside)



Daibutsu Daienji



Kamado Shrine

Fukuoka-shi



Mt. Sangun



Nephila clavata



Ubytování



Meinohama Eminence – 24m²





Guest house – 55m²



Dormitory – 45m²



Dormitory

Ubytování

住民異動届書 (あて先) 福岡市 区长

※ボールペンで「色ワク」の中をはっきりと書いてください。
※健康保険証・年金手帳があれば、提出してください。

届出事項
1. 市外からの転入 2. 区間異動 3. 市内からの転入 4. 管内転居
5. 市外への転出 6. 世帯主変更 7. 世帯合併・分離 8.

届出人の氏名(本人又は世帯主) 代理人の住所・氏名(委任状を添付してください)

届出日 平成 年 月 日
異動日 平成 年 月 日

新住所 デービッド コスタル
旧住所

住所確認済 (住居表示台帳・固定) (オンライン・方書)

No	氏名	生年月日	性別	続柄	児童生徒 旧学校 学年	指定学校 転入学日	国民健康保険 加入状況	後期高齢者医療 加入状況 被保険者番号	介護保険 加入状況 被保険者番号	国民年金 基礎年金番号 種別	世帯主
1	明・大・昭・平	男・女	男	小中 年生	小中 年生	小中 年生	加入 持参	加入 持参	加入 持参	昭・平	有・無
2	明・大・昭・平	男・女	男	小中 年生	小中 年生	小中 年生	加入 持参	加入 持参	加入 持参	昭・平	有・無
3	明・大・昭・平	男・女	男	小中 年生	小中 年生	小中 年生	加入 持参	加入 持参	加入 持参	昭・平	有・無
4	明・大・昭・平	男・女	男	小中 年生	小中 年生	小中 年生	加入 持参	加入 持参	加入 持参	昭・平	有・無
5	明・大・昭・平	男・女	男	小中 年生	小中 年生	小中 年生	加入 持参	加入 持参	加入 持参	昭・平	有・無

児童手当 有・無
児童手当 有・無
児童手当 有・無
児童手当 有・無
児童手当 有・無

1. 普通便箱 (水所) 11階まで使用
2. 無臭便箱 (水所) 22階層以上で使用
3. 脱臭水洗便箱 (水所)

国民健康保険 介護保険 児童手当 障がい手帳 療育手帳

通知カード

個人番号 7528 7646 4952
氏名 KOSTAL DAVID

住所 福岡県福岡市西区姪の浜2丁目11番3-2
02号

1985年12月5日生 性別 男
発行日 平成30年10月3日

福岡市長宛
(地方公共団体情報システム機構 宛)

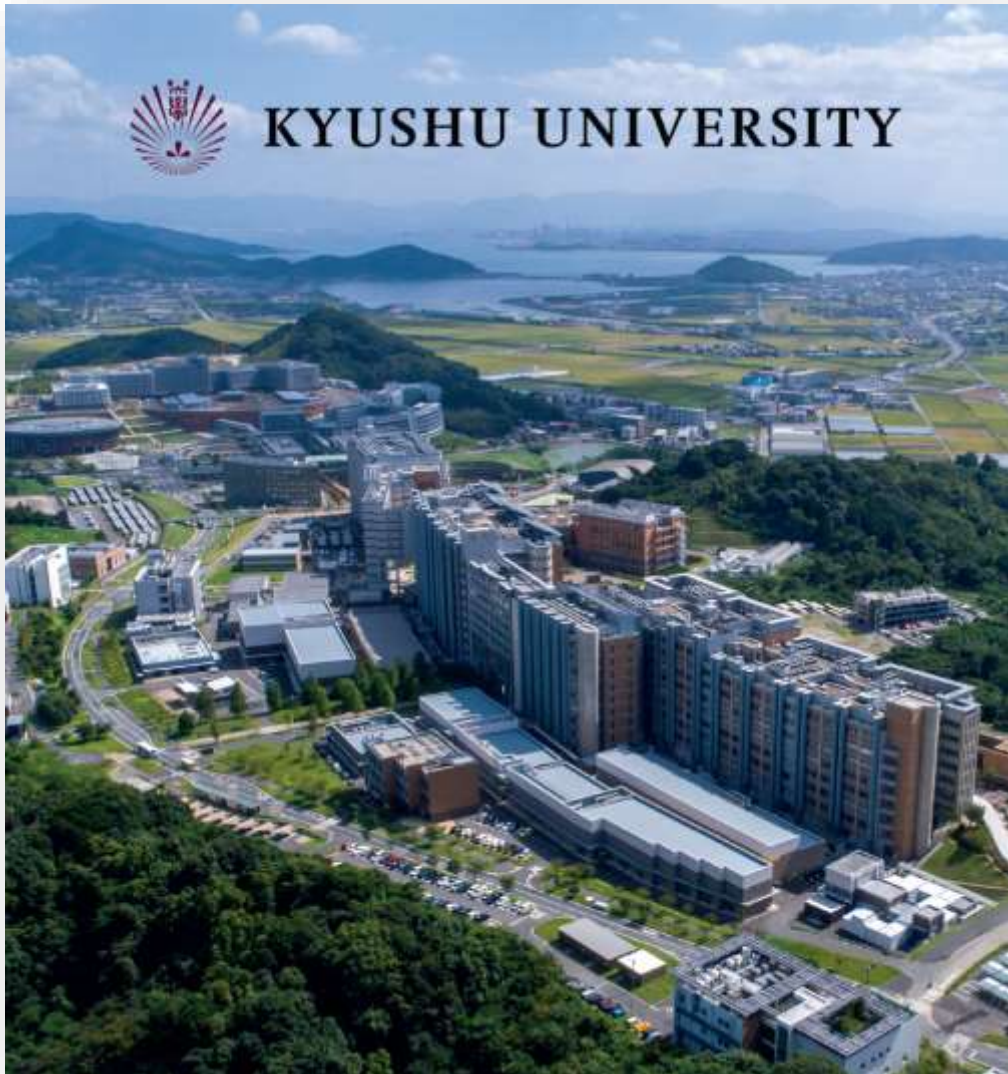
個人番号カード交付申請書
兼 電子証明書発行申請書

申請書ID 4013 5201 8100 3000 2746 552

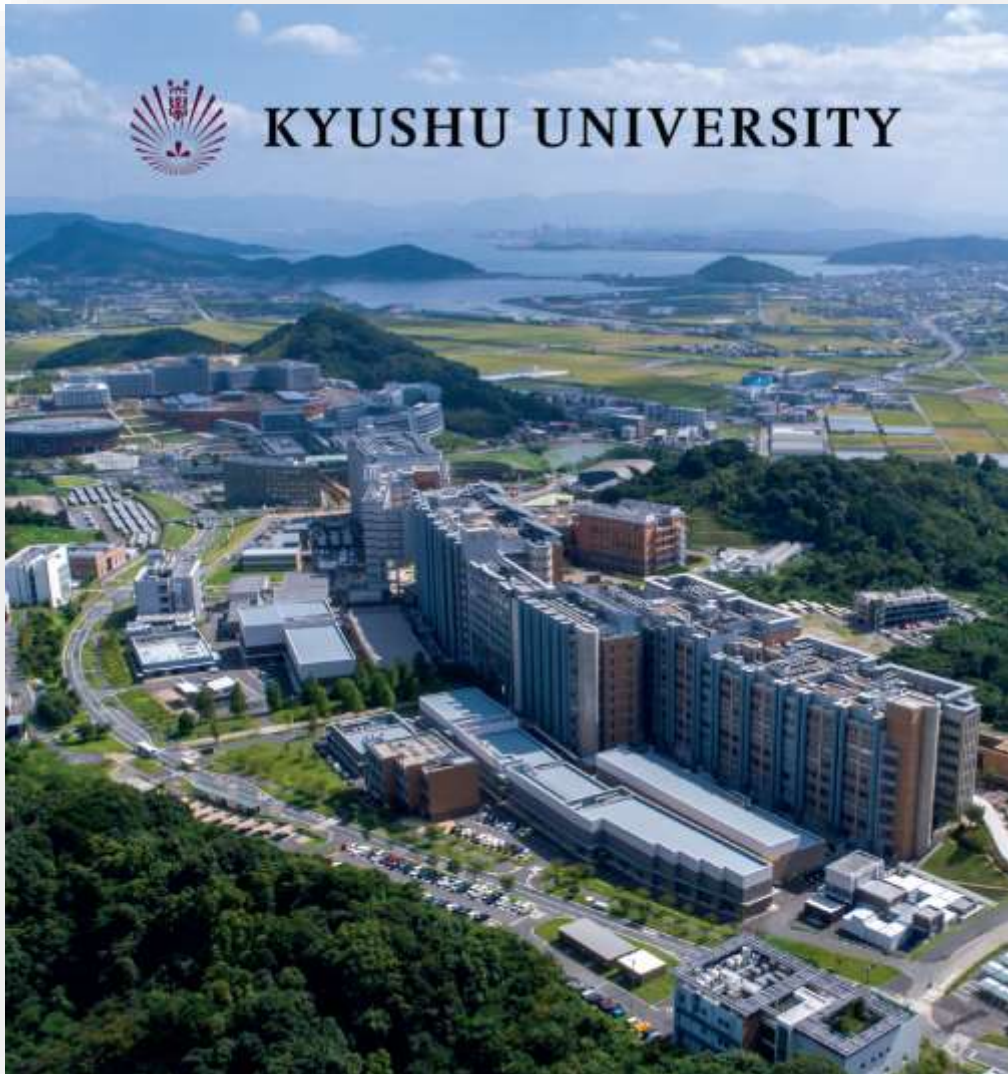
氏名 KOSTAL DAVID

3-202号

Kyushu University - ITO Campus



Kyushu University - ITO Campus



- Undergraduate schools: 11
- Graduate schools: 18
- Faculties: 16
- Research institutes: 5
- Academic staff: 2315
- Administrative: 2769
- Students: 18 925
- QS Rank: 126 (BUT – 651-700)



International Institute for Carbon-Neutral Energy Research,
Kyushu University

HYDROGENIUS



*Research center for
Hydrogen Industrial Use and Storage*

Kyushu University - ITO Campus



Mechanical engineering



Office view

Fluorescence – main topic

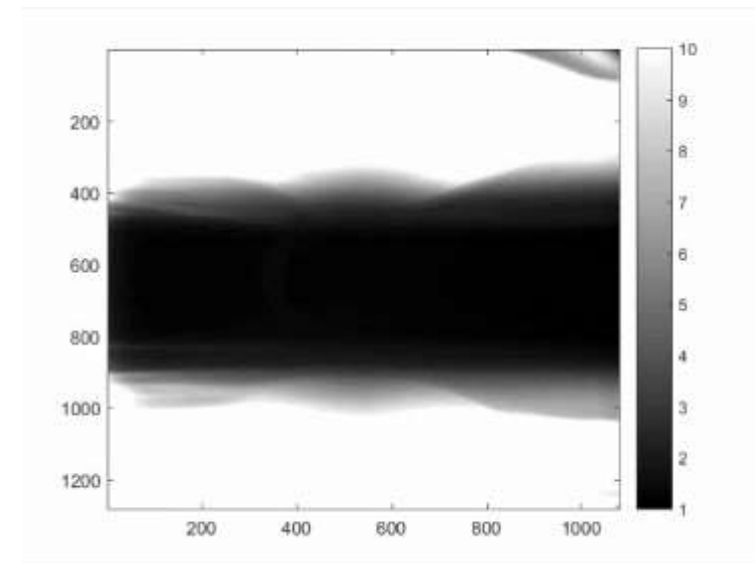
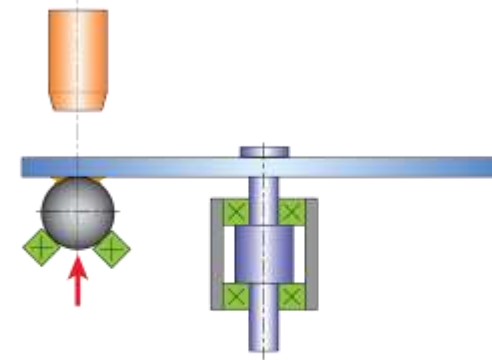
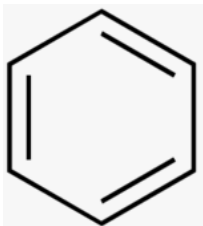
Main idea:

To use fluorescence dyes to improve observation of the grease samples.

- Improve fluorescence intensity and stability

Current state:

Fluorescence is used only with „natural“ ability of some lubricant – has to contain aromatic hydrocarbon.

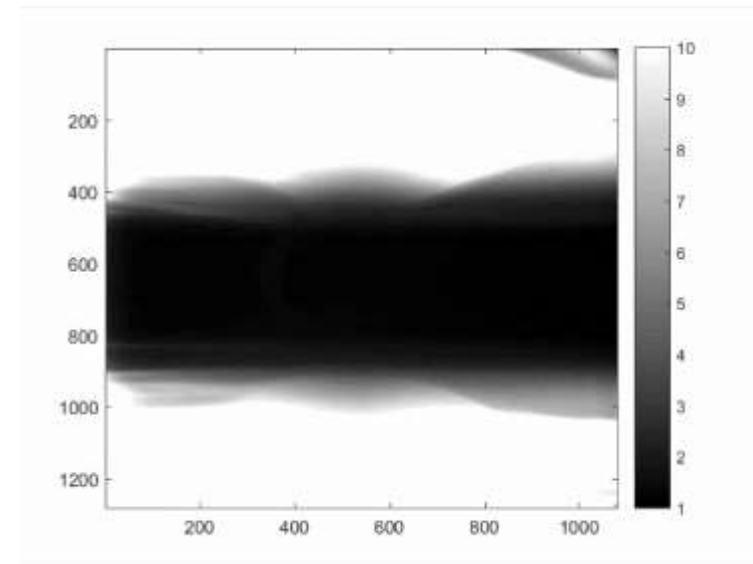
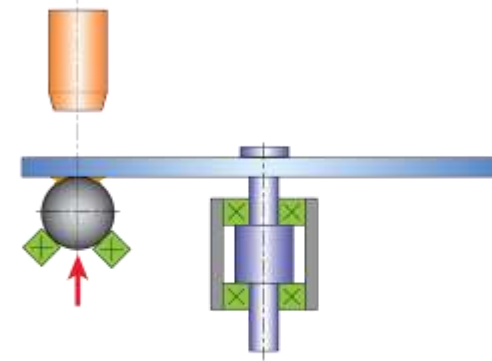
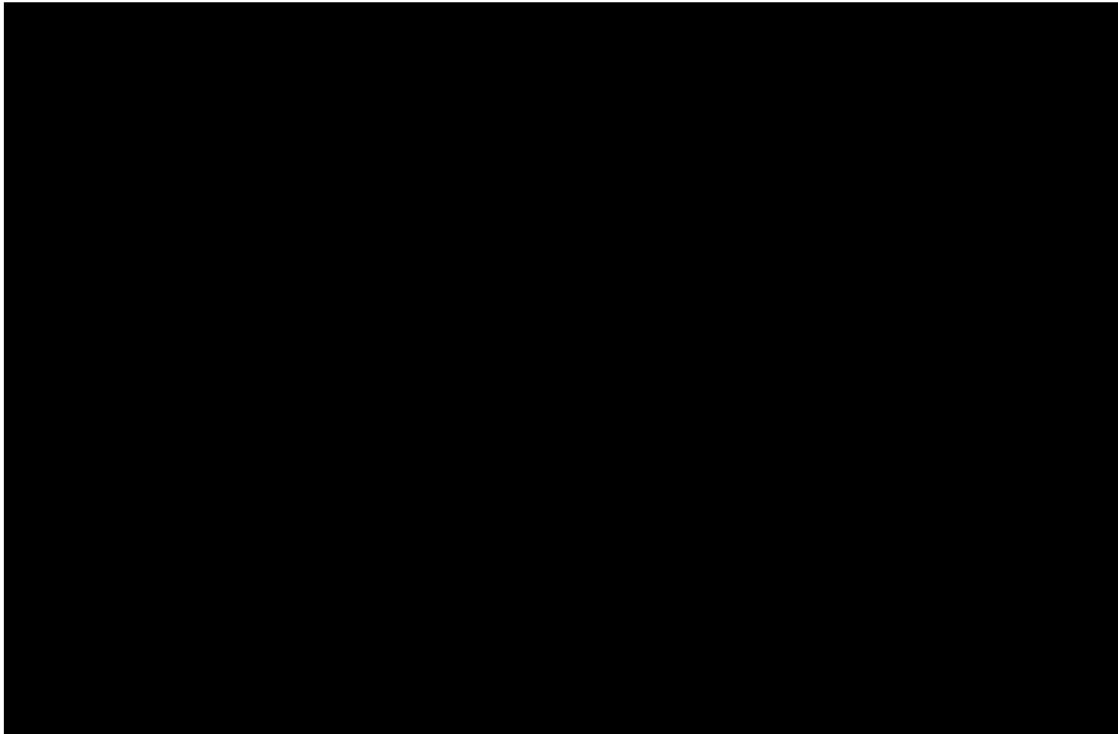


Fluorescence – main topic

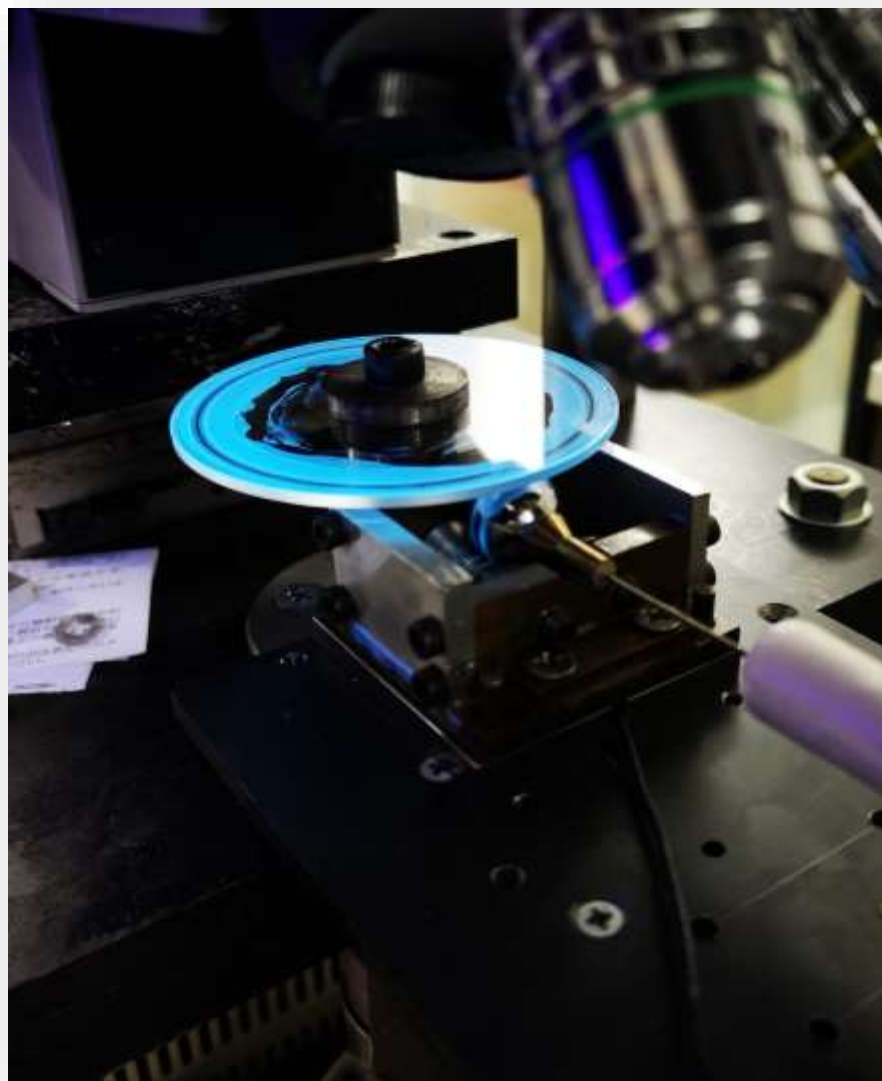
Main idea:

To use fluorescence dyes to improve observation of the grease samples.

- Improve fluorescence intensity and stability
- Separate observation of the thickener and base oil



Fluorescence



Fluorescence

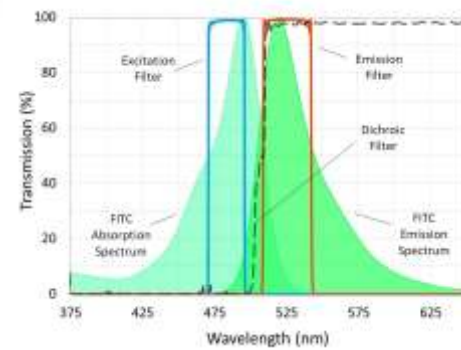
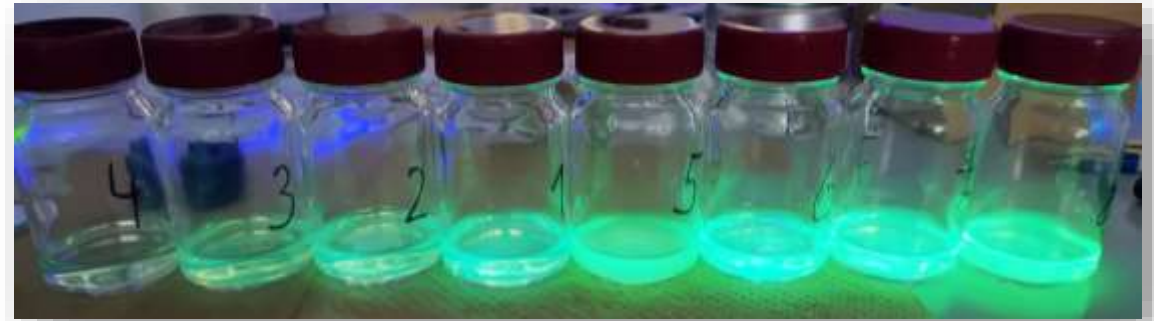
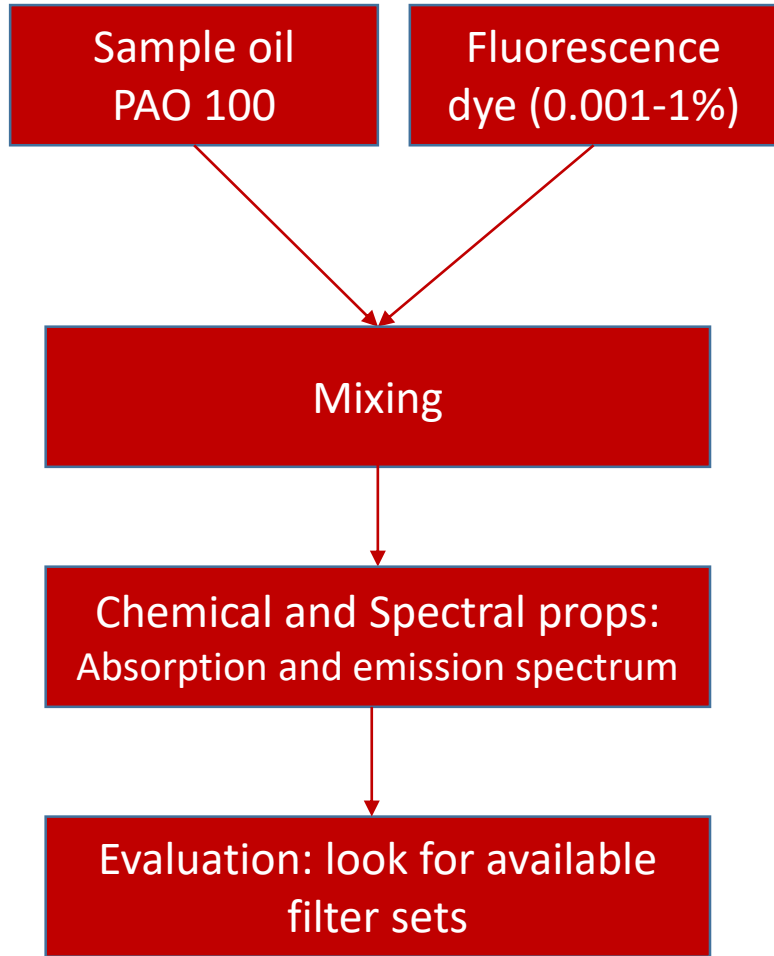


Figure 6

Fluorophores

First goal: To find dye available for the use with oil / grease

Lubricant sample: PAO 100

Fast screening with all available dyes:

Diphenyl – Octateraene

Acridine

Acridine orange

Azulene

Coumarin 6

Fluorescein

M-Terphenyl

Perylene

Pyrene

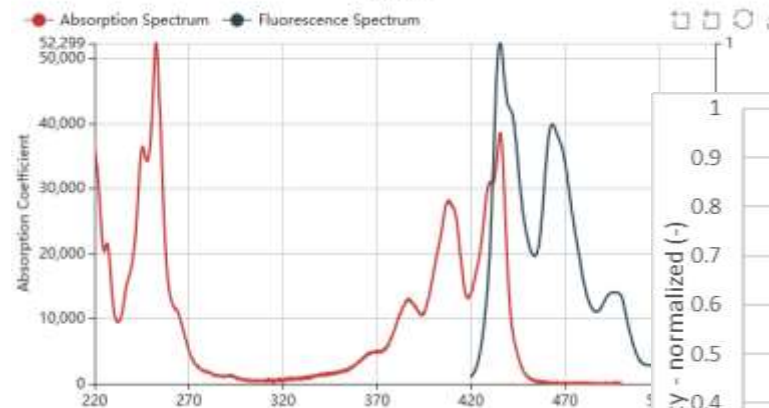
Rhodamine B

Safranin-O

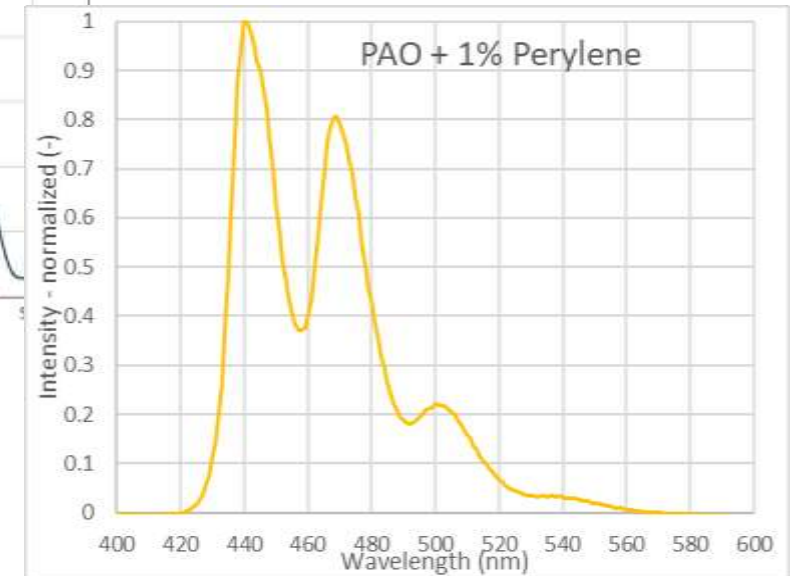
Tetramethyl diaminodiphenylmethane



Literature: Perylene

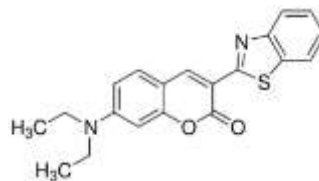


Experimental:

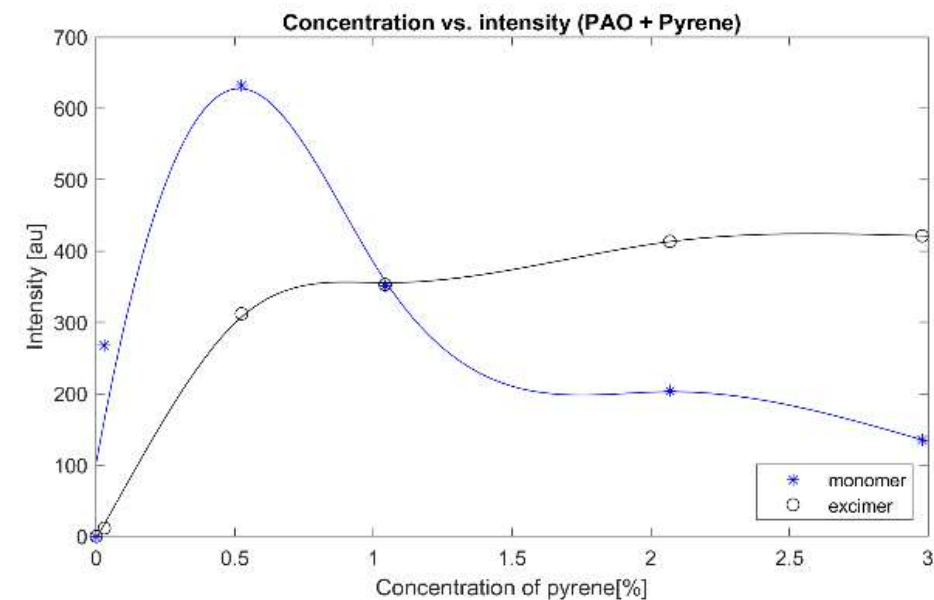
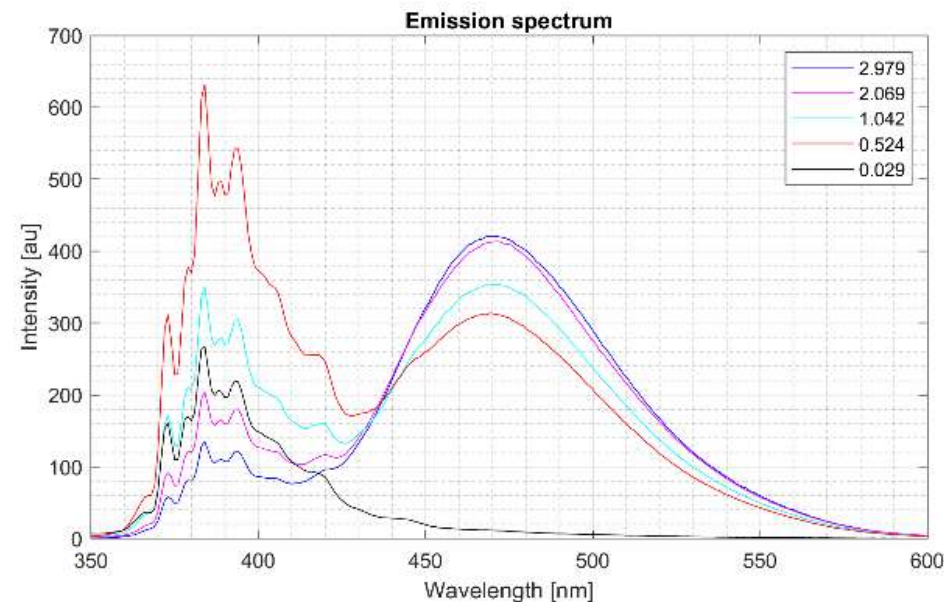


The best: **Pyrene** and **Coumarin 6**

Fluorophores



	Pyrene	Coumarin 6
Benefits	Stable emission	Low concentration / high intensity
Effective concentration	0.5-1%	0.02 %
Maximal concentration	3%	0.05 %
Ex/Em (nm)	317 / 382 ; 473	455 / 464
Filter set	Nikon UV-2A	Chroma 19001
Excitation light	Hg lamp	Hg lamp, LED

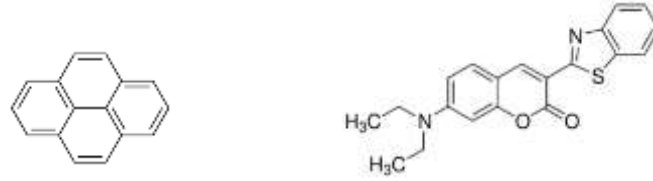


Pyrene

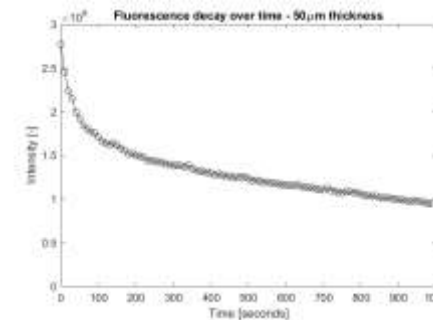
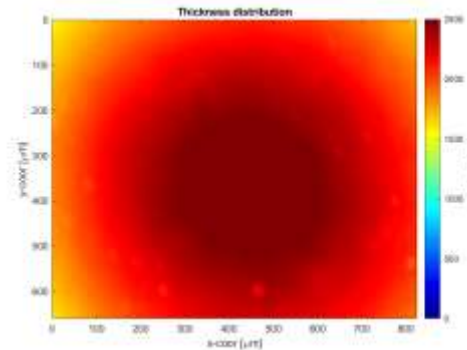
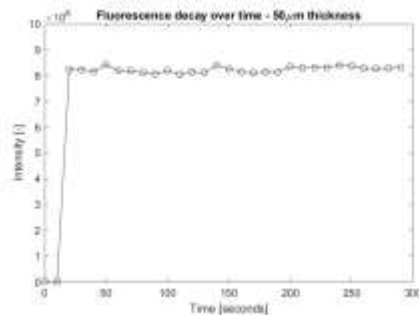
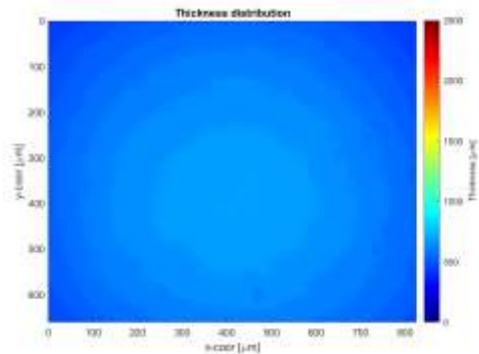
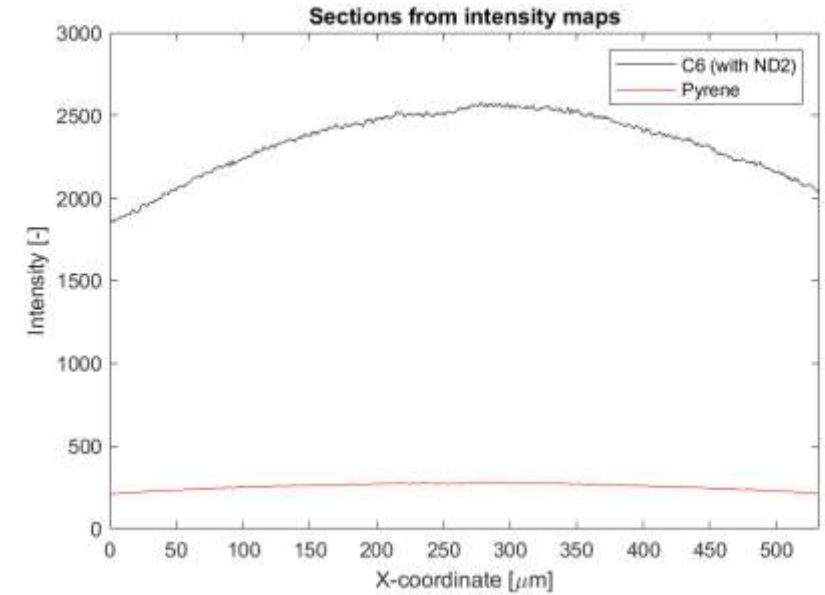


Coumarin 6

Fluorophores

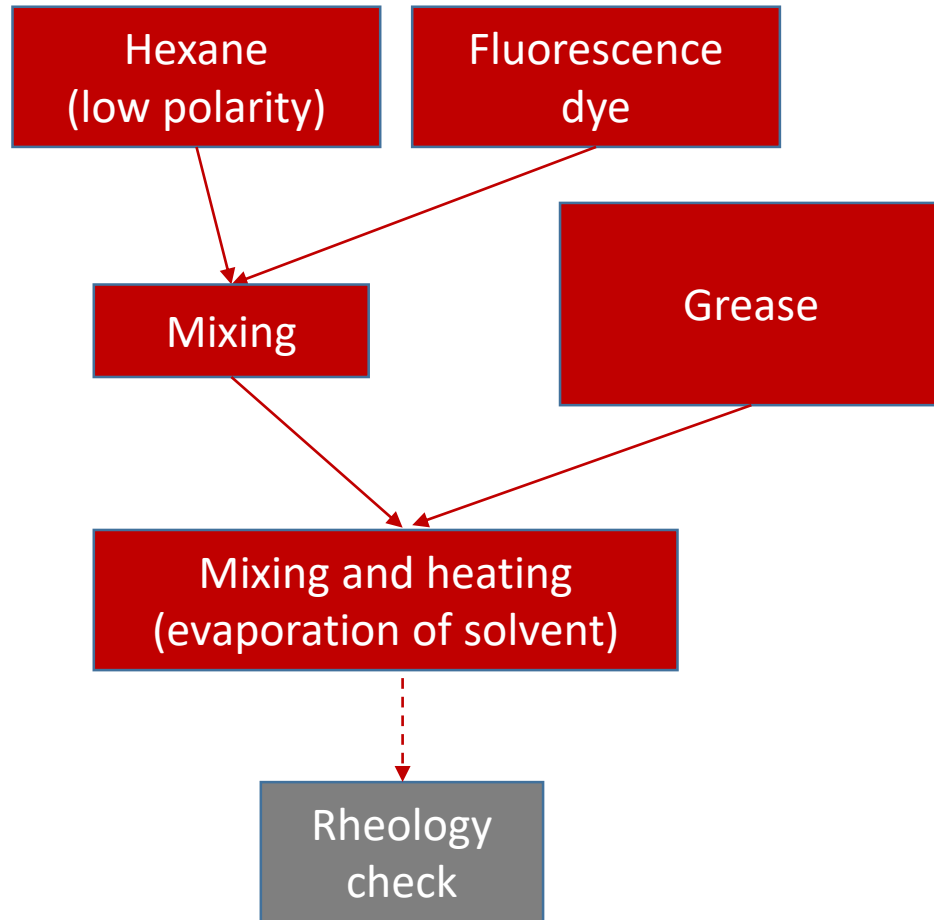


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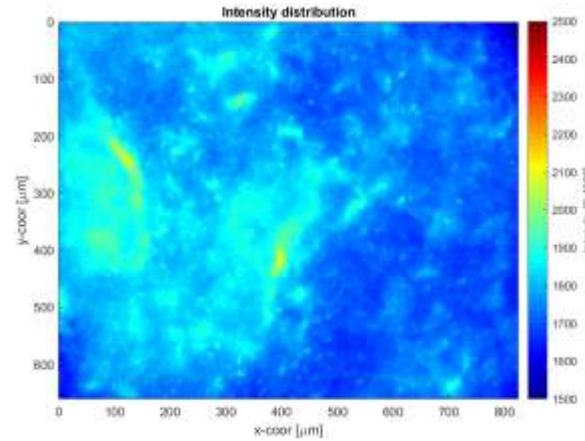


Grease augmentation

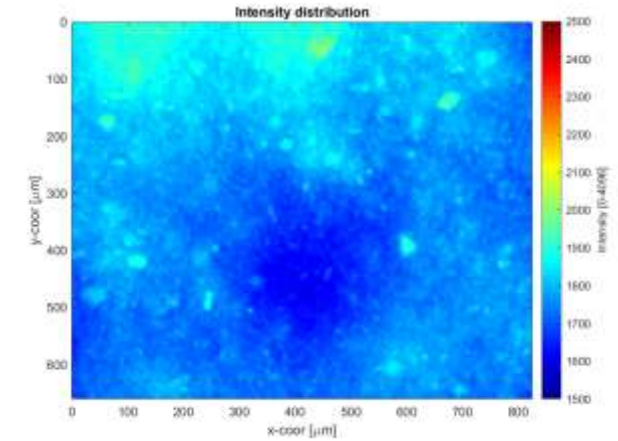
Use of the selected dyes with grease:



Dye added into oil:



Dye added into grease:



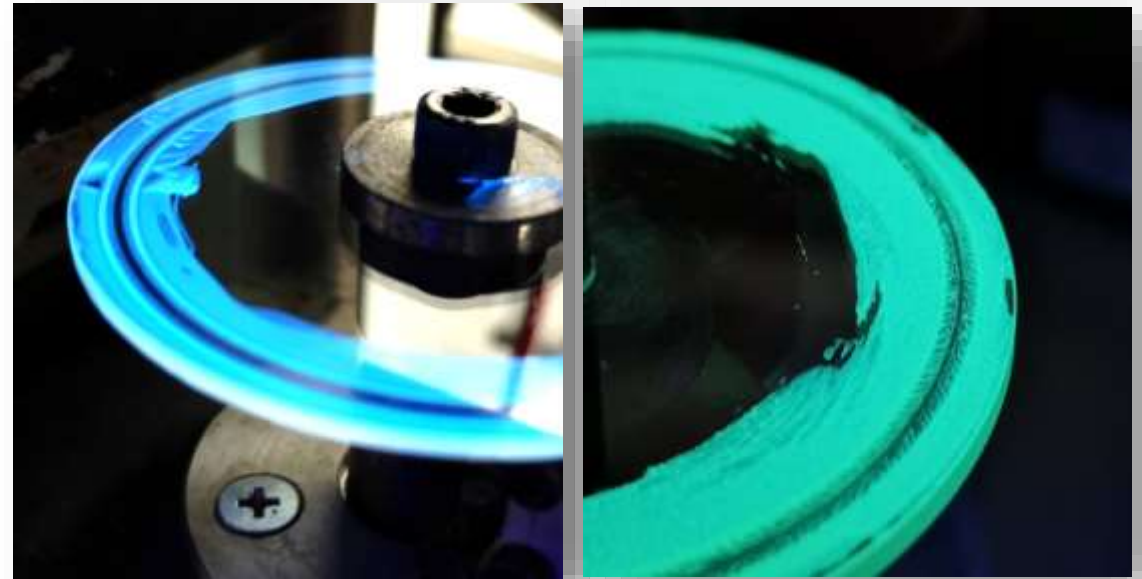
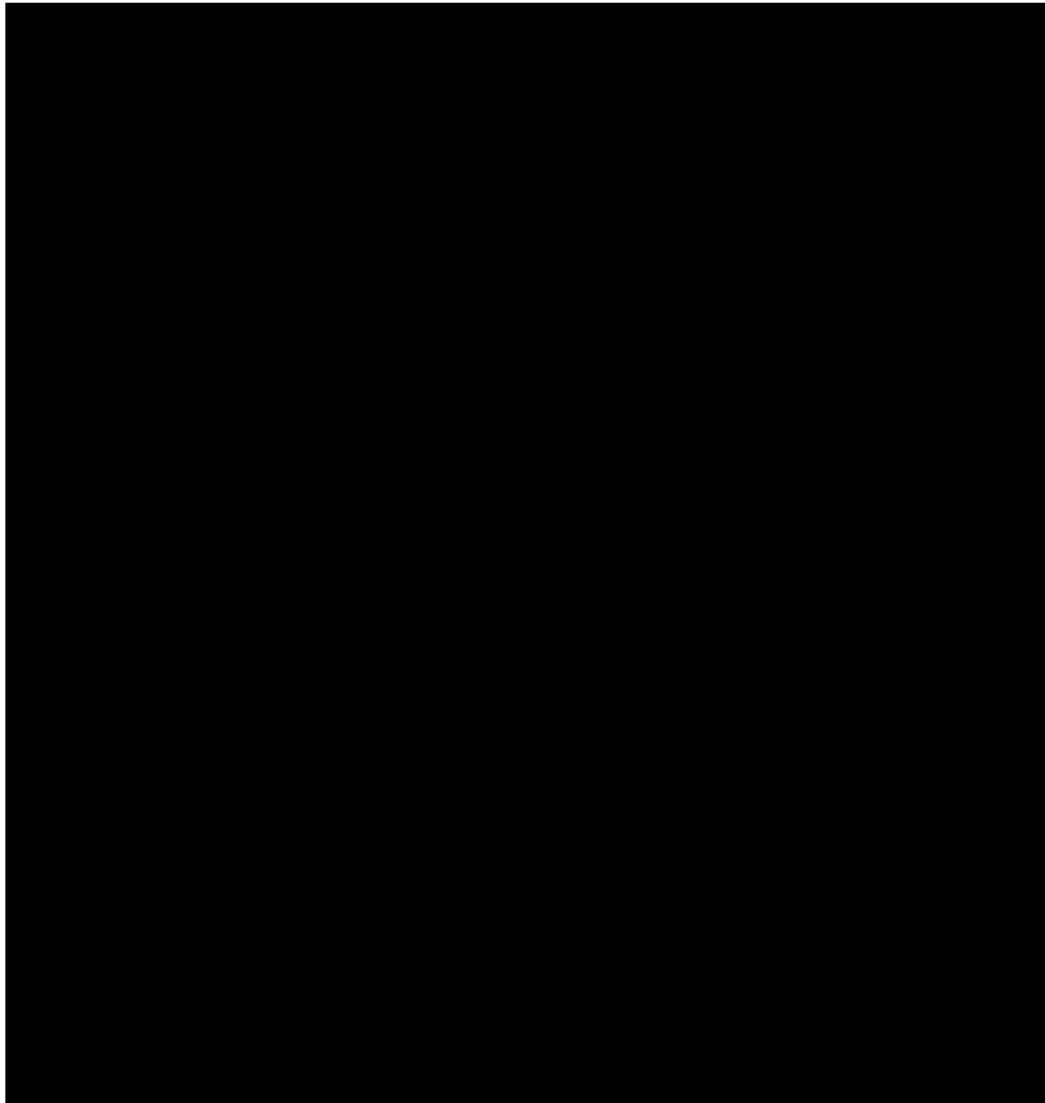
Method has been verified on

- Fluorescence microscope – homogeneity evaluation
- Cone on plate rheometr – elasticity and viscosity

Both proved method to be safe for grease

Grease augmentation

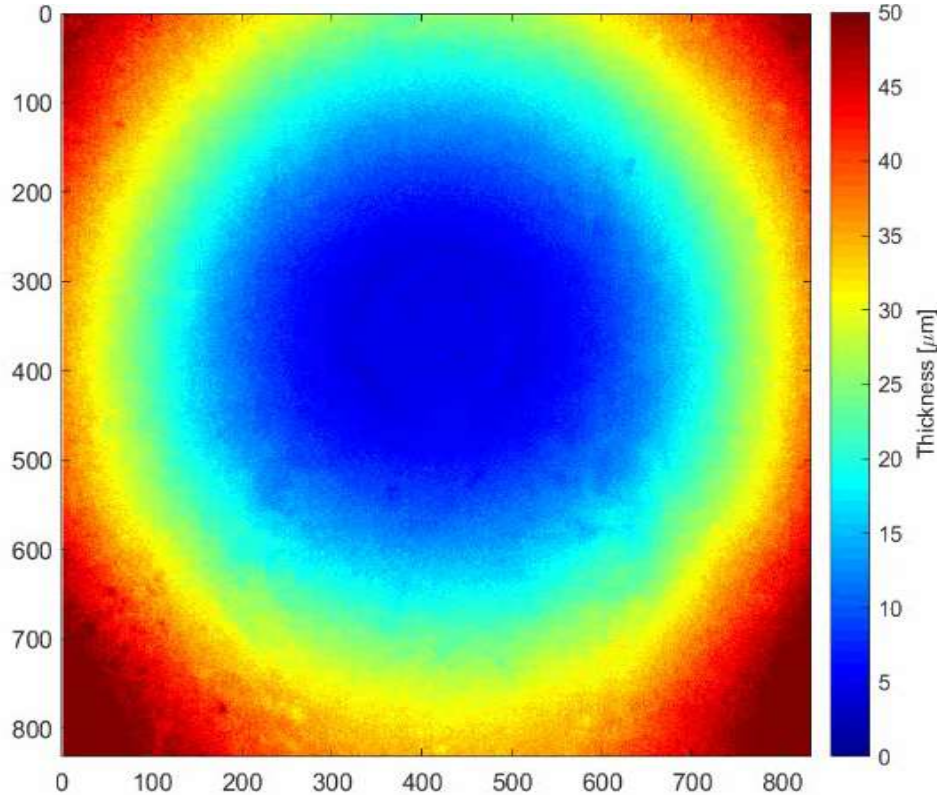
Separate observation of the grease constituents:



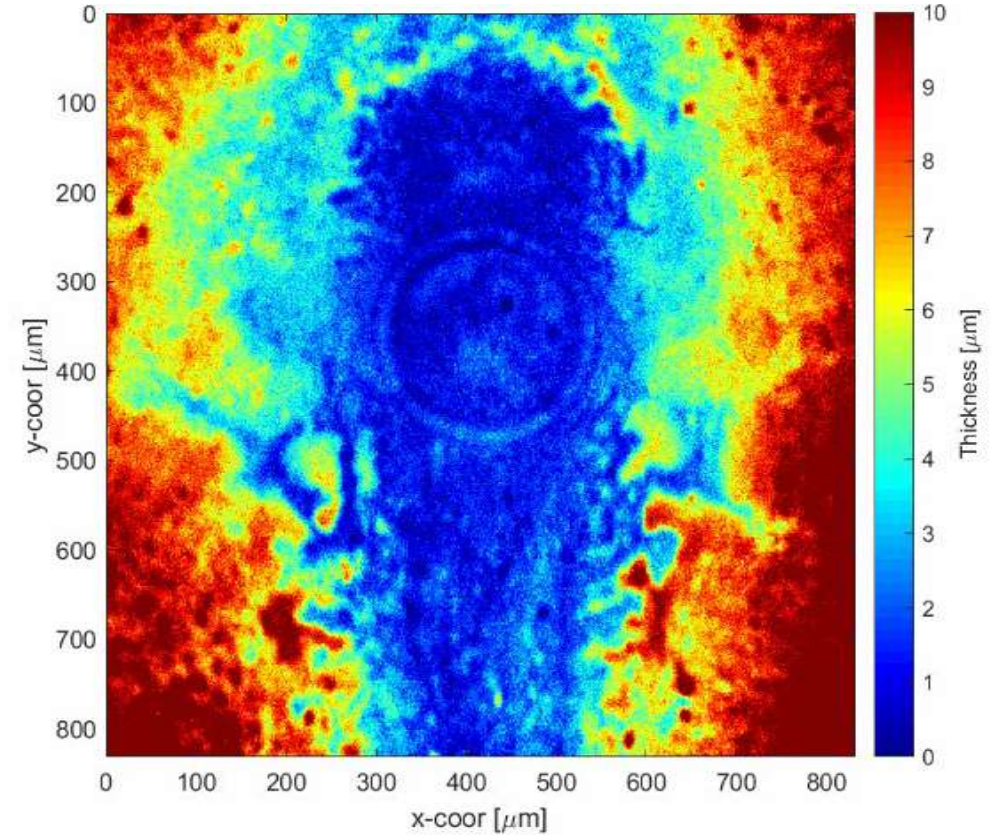
Grease augmentation

Separate observation of the grease constituents: Same conditions, lubricant, excitation, camera, everything but the **filter set**.

Pyrene (oil):



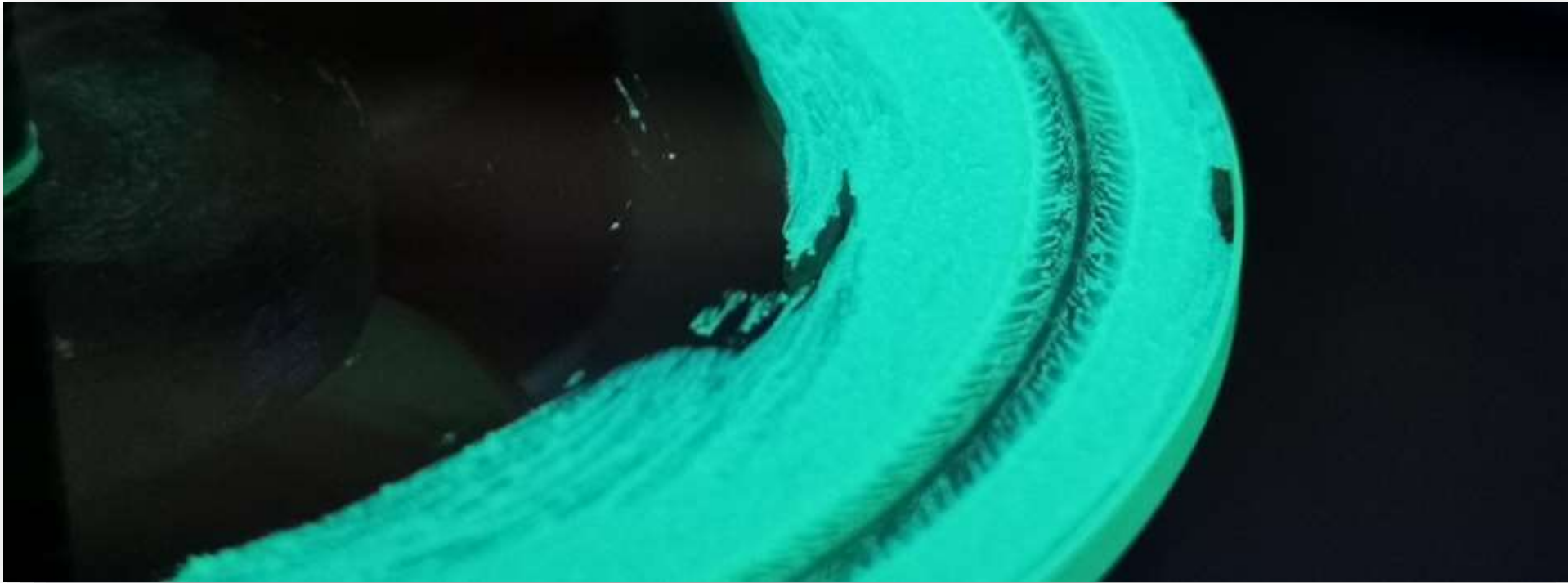
Coumarin (thickener):



Method has been verified with the use of FT-IR (evaluation in progress)

Future...

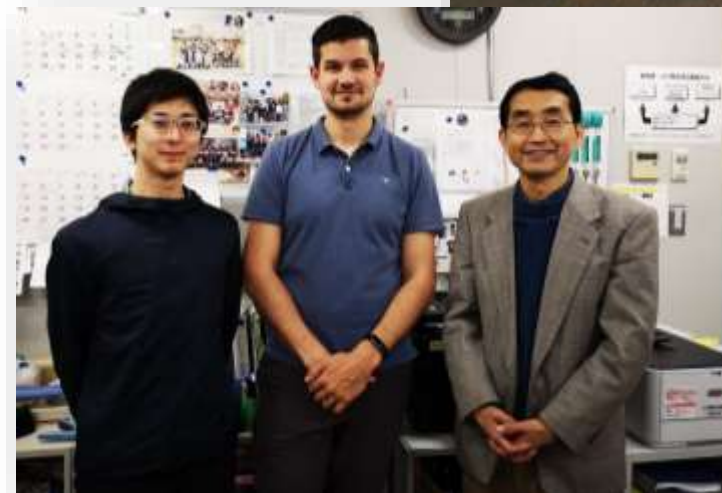
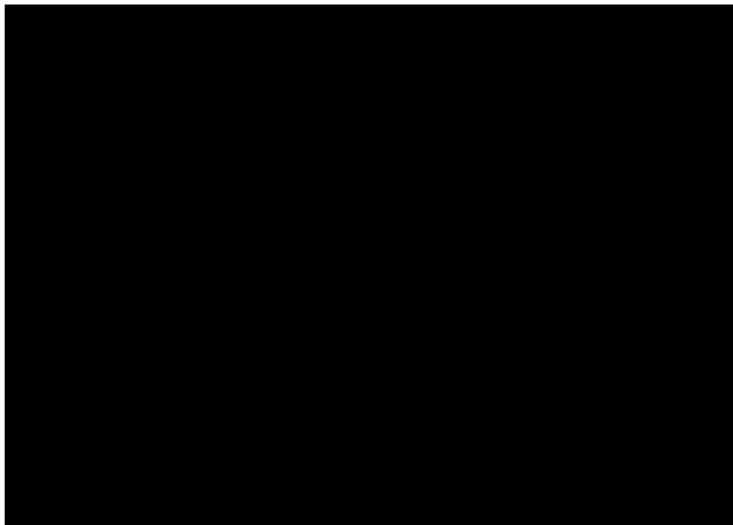
- Verify the separation of the thickener and oil -> paper if it works correctly
- Apply the methods for our test rigs (obtain filters)
- Use the method for study the thickener behaviour in the contact and track (e.g. Presence of the thickener in the track, change of the relative composition of the lubricant)



Summary - work

6 months at Kyushu University:

- Obtained much deeper understanding of the fluorescence principle and other experimental methods such as Spectrometry, Spectrofluorometry, FT-IR, Raman...
- Visit (+ lab tour) at Yokohama National University and Kitakyushu Institute of Technology
- Two days stay in JXTG (Japan petroleum Company) - Lab tour and grease manufacturing process
- Invited lecture at Sakura event for Japanese and Chinese student about tribology
- ICETAT conference in Taipei (Taiwan) - presentation
- Participation at two local conferences (Icner and Hydrogenius)
- One article prepared to submission, potential for two more



Summary - personal

Checklist for Japan:

- ✓ Survive
- ✓ Eat a lot of rice and sushi
- ✓ Experience Typhoon
- ✓ Experience Earthquake
- ✓ Try some new sea related sports (scuba diving and windsurfing)
- ✓ Climb highest peak of Kyushu island (mt. Nakadake)
- ✓ Coffin hotel

Failed to:

- Experience volcano eruption (only small – does not count)
- Play pachinko slots
- Climb Fuji-san (closed for winter)
- Loose weight (exquisite sweet bakery)



Thank you for attention

David Košťál

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INSTITUTE OF MACHINE
AND INDUSTRIAL DESIGN