Infrastructure for fabrication of optical fiber-grade non-oxide soft glasses and components

IDUB I.4.2 Proposal

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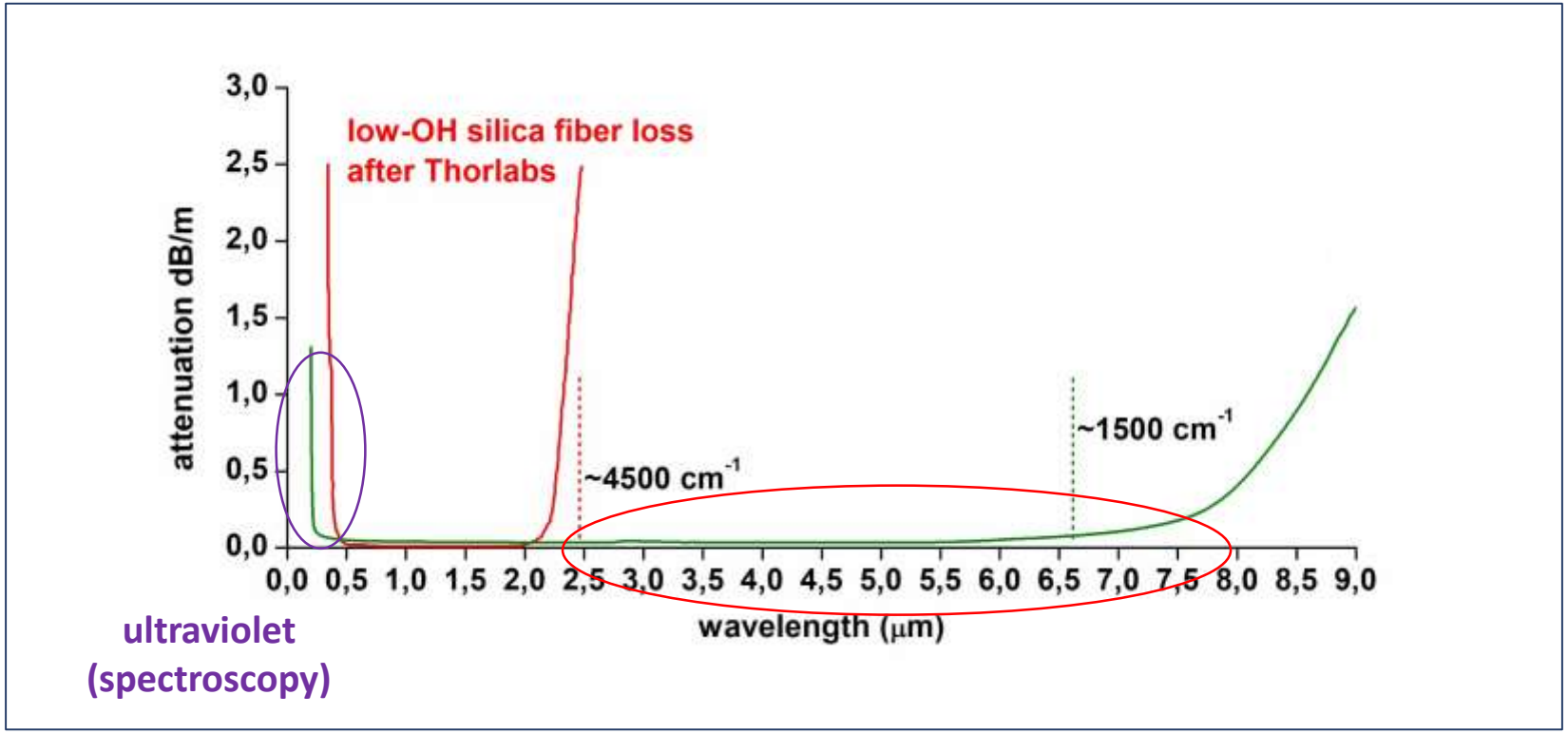
Proposal overview - motivation

Optical fibers:
- Telecommunications
- Lasers
- Sensing

The main material
- **Fused silica**

Pros:
- ✓ **So far unrivalled transparency (near infrared and visible)**
- ✓ **Mature tech = low cost of fiber**
- ✓ **High durability**

Cons:
- High cost of fiber-grade starting materials (only common fiber types are cheap)
- High processing temperatures
- Transparency limited to VIS and NIR
  no access to UV
  no access to mid-infrared



spectral fingerprint region – spectroscopy
nondestructive imaging

Proposal overview - justification

what substantial added value for the UW this project will bring?

Implementation of project will bring non-oxide glass fabrication to Ochota Campus:

AND

Currently unavailable:

- UV and Mid-infrared fibers & imaging bundles
- UV and Mid-infrared optical components

- UV & MidIR Light – sensing, data transfer,

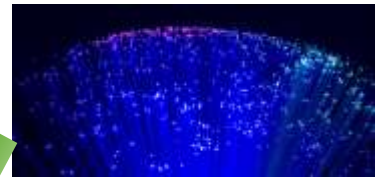
- Optical fiber and imaging bundles
  - adjustment free
  - easy to handle
  - selective
  - sterile

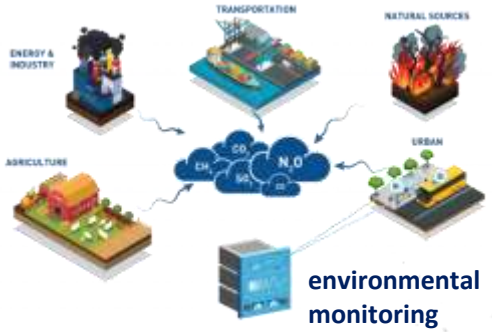
Existing standard fiber technology:

UV | visible | near-infrared | **mid-infrared**

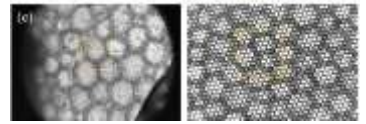
Impact on world science

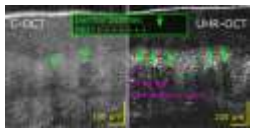
Opening ultraviolet and mid-infrared light to optical fibers & components





Mid-infrared 'can see' through hard materials: ceramics and plastics





Noninvasive, sterile biological sample imaging& fast diagnosing

Image credits: DTU Fotonik (declared foreign partner)
Nesspresso, Buczyński group at FUW, public domain

Project content & current stage of realization

Purchase of Infrastructure: complete glass melting station for ultra-high purity fabrication of fiber-grade non-oxide glass

Implementation includes complete, new equipment required for immediate start of operation:

1) Dual chamber glove-box (1. raw materials storage and preparation; 2. glass melting and annealing)

2) Inert gas purifier to remove oxygen and moisture from glove box atmosphere.

3) Solvent absorber system to remove post reaction compounds.

4) Set of detectors – moisture, oxygen for monitoring internal atmosphere parameters.

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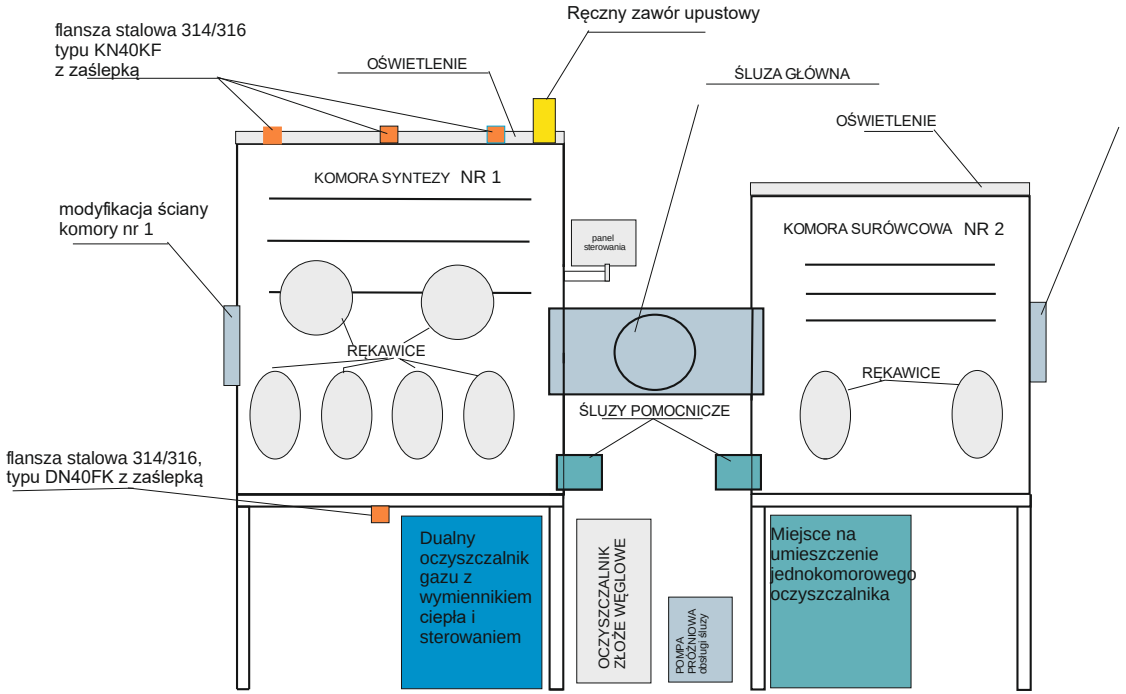


Project content & current stage of realization

Purchase of Infrastructure: complete glass melting station for ultra-high purity fabrication of fiber-grade fluoride glass

Implementation includes complete, new equipment required for immediate start of operation:

1) Dual chamber glove-box (1. raw materials storage and preparation; 2. glass melting and annealing)

2) Inert gas purifier to remove oxygen and moisture from glove box atmosphere.

3) Solvent absorber system to remove post reaction compounds.

4) Set of detectors – moisture, oxygen for monitoring internal atmosphere parameters.

Project content & current stage of realization

Ongoing processes:

Purchase of technical materials and assembly of processing chamber and temperature controllers – **completed**

Raw materials:

Purchase of raw materials for glass smelting - possible only after the chamber is operational due to storage requirements

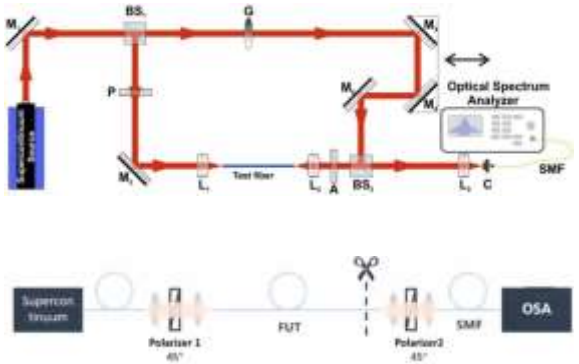
Currently no raw materials for glass development - Public order procedure – on going

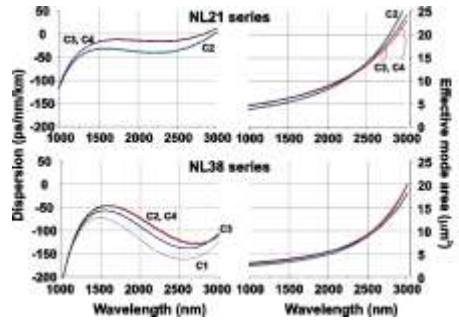
Project-relevant expertise in our group

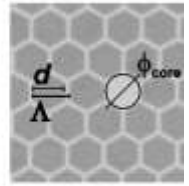
Glass & fiber characterization and experimentation exprtise

Versatile characterization of **linear properties**
Examples:

- Material dispersion (glass) and chromatic dispersion (fiber) - Michelson and Mach-Zehnder interferometers
- Birefringence
- Attenuation, bend loss, numerical aperture & mode field diameter & the like.

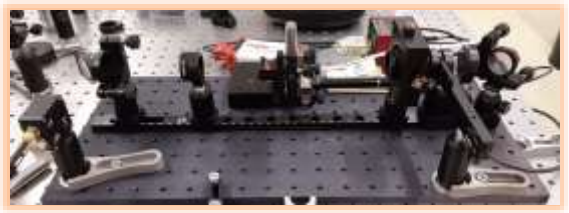


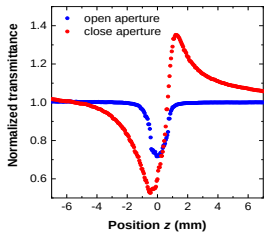


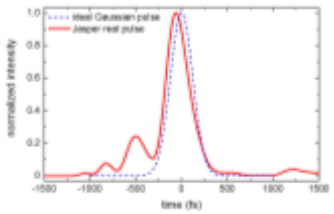


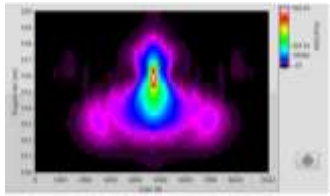
Characterization of **nonlinear optical properties** and **ultrashort laser pulse propagation dynamics**

- Z-scan
- Frequnecy-resolved optical gating (FROG) and
- cross-correlation frquency resolved optical gating (XFROG)









Conclusions

- Declared equipment purchased, installed and comissioned
- Lengthy tender procurement and administrative requirements
  bottleneck procurement of critical raw materials
- We are open for campus collaboration - our expertise your applications
- No fees , as default.
- 3-4 undergrads or graduate students taking advantage of the availability of the proposed technology in their dissertation or diploma workshops per annum (2 PhD students are working now @ 02/2023).
- Preferred collaboration model – joint papers and externally funded grant proposals for Ochota Campus-driven interdisciplinary research

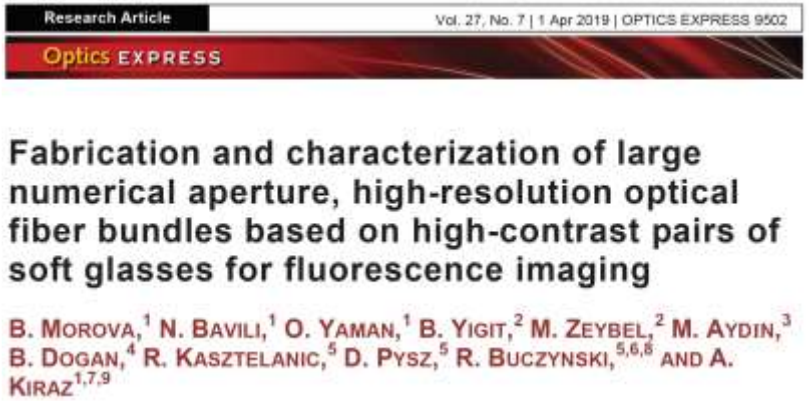
Our track record in the last 5 years SPEAKS FOR US!

Number of peer-reviewed papers (IF journals only, no mdpi): >100

Including:
Number of papers in collaboration with leading foreign groups: 50
&
Number of cross-disciplinary papers in collaboration with other groups (optofluidic, bioelectrochemistry, bioimaging): 15


Contents lists available at ScienceDirect
Bioelectrochemistry
journal homepage: www.elsevier.com/locate/bioelechem
Ultrathin glass fiber microprobe for electroporation of arbitrary selected cell groups
Julita Kulbacka, Rafał Kasztelanic, Małgorzata Kotulska, Dariusz Pysz, Grzegorz Stępniewski, Ryszard Stępień, Jolanta Saczko, Damijan Miklavčič, Ryszard Buczyński


nature COMMUNICATIONS
ARTICLE
OPEN
Two octave supercontinuum generation in a non-silica graded-index multimode fiber
Zahra Eslami, Lauri Salmela, Adam Filipkowski, Dariusz Pysz, Mariusz Klimczak, Ryszard Buczynski, John M. Dudley & Goëry Genty


Research Article
Vol. 27, No. 7 | 1 Apr 2019 | OPTICS EXPRESS 9502
Optics EXPRESS
Fabrication and characterization of large numerical aperture, high-resolution optical fiber bundles based on high-contrast pairs of soft glasses for fluorescence imaging
B. Morova, N. Bavili, O. Yaman, B. Yigit, M. Zeybel, M. Aydin, B. Dogan, R. Kasztelanic, D. Pysz, R. Buczynski, and A. Kiraz