Funded by the European Union

FunctiGlass

Project title: Planar Er^{3+} doped germanate glass-ceramic waveguide with strong 2.7µm emission

Recruiting institution: Tampere University

Background
Over the past four decades, glass, glass-ceramics and composites have contributed to the most advanced socio-economic breakthroughs as high-tech materials. To compete with emerging economies such as China and India, the European glass sector must strive for product leadership by investing more in research and innovation to develop new materials and train specialists for a competitive but promising market.

Contributing to this challenge is the main objective of the 'Structured functional glasses for lasing, sensing and health applications' (FunctiGlass) project, dedicated to advanced high-tech materials for three sectors: light sources, sensors and biological applications.

FunctiGlass, supported by the CNRS, is a unique interdisciplinary research and training programme with a double degree as part of Horizon Europe's Doctoral Networks (Marie-Sklodowska Curie Actions). It will train 11 doctoral candidates who will take part in a joint research training programme based on very close cooperation between academia and industry. It will ensure that the trainees are exposed to 11 academic environments (universities and research institutes) and 9 non-academic environments (industry and SMEs) representing 9 different countries. **Each PhD candidate will be supervised by two academic tutors from different units and one mentor (industrial partner)** to ensure cross-sector knowledge sharing and the acquisition of transferable skills with a focus on entrepreneurship and innovation. Through the multi-dimensional training of the

FunctiGlass programme, the 11 PhD candidates will excel in the future economy by acquiring a multi-dimensional perspective and mindset to become future leaders in glass science and in particular glass-based nano/micro-structured materials. Through this programme, they will find their own path of innovation in academia or industry.

The project will create the conditions necessary for the establishment of long-term relationships between the academic and private sectors for the transfer of technologies and skills.

5 institutions will award the double degrees: Université Côte d'Azur (Nice, France), Tampere Universities (Finland), Gottfried Wilhelm Leibniz University Hannover (Germany), University Milano-Bicocca (Italy) and the Institute of Low Temperature and Structure Research, Polish Academy of Sciences (Wroclaw, Poland).

Industrial partners: AOI Tech (France), Corning (France), Fastlite (France), Klearia (France), Else Nuclear (Italy), Nobula3D (Sweden), Nyfors Teknologi (Sweden), Rosendahl Nextrom (Finland), Scout Scientific Outsourcing (Poland).

Other universities involved in the project as partners (not awarding doctoral degrees): University of Cergy-Pontoise (France), University of Gent (Belgium), University of Pardubice (Czech Republic), University of Nazarbayev (Kazakhstan), Umeå University (Sweden).

Description of the PhD project

Er3+ doped glass thin films have been demonstrated to be an appealing candidate for the development of efficient photonic systems such as microcavities, solid state lasers, integrated optical amplifiers, and optical sensors [1]. Glass systems having germanium dioxide as the major component are promising because germanate glasses have high linear refractive index nearly up to 2.2 and can form a glass matrix by acting as a host for different oxides including lanthanide oxides. Additionally, germanate glasses have low phonon energies (< 800 cm-1) and good optical transmission. The incorporation of Erbium (Er3+) in germanate glasses is particularly useful since Erbium has a broad emission at 2.7μm wavelength. Glass-ceramics (GCs) offer a promising alternative since these materials combine crystalline and vitreous responses. Higher absorption/emission cross-section and longer lifetime of luminescent levels can be achieved if the Er3+ ions are located in the crystals with specific crystalline phase [2]. GCs are based on the nucleation and growth process. A thermal treatment is applied to glasses in order to create nuclei and grow them into crystals.

For integrated photonics, the glass needs to be deposited into a thin film onto a substrate. Various techniques based on physical and chemical methods have been developed to deposit glasses into films [3-5]. Radio-frequency (RF) magnetron sputtering is a common approach to fabricate thin films. Compared to evaporation based deposition techniques, RF magnetron sputtering can be performed at lower temperatures with less deterioration to the target material since it is momentum based while resulting in better adhesion of the film onto the substrate [6]. Sol-gel has been shown as another profitable fabrication method to produce glass thin films [7], thanks to its low temperature and melt-free synthesis, and ease of multicomponent fabrication.

In this PhD topic, it is planned to develop new germanate glass-ceramic planar waveguides. Er3+ doped glasses will be developed with the main goal to understand the relation between the glass composition and the spectroscopic properties in order to engineer glasses with strong 2.7μm emission. A thermal treatment will be used to develop glass-ceramic. Glasses will be prepared using melting process and the most promising glasses will be deposited into films using RF magnetron sputtering. Glasses will be also prepared using sol-gel technique and films will be deposited using spin-coating. Layers of an approximate thickness around 700nm with strong NIR emission are targeted. The final goal is to fabricate waveguide using laser irradiation and lithography processes.

The main objectives of the PhD are to:

- Advance the sol-gel process to prepare germanate glass with target composition
- Investigate the nucleation and growth mechanism of glasses with different compositions in order to prepare transparent glass-ceramics with enhanced spectroscopic properties
- Advance fundamental understanding of film deposition using different techniques (spin coating, sputtering) on glass composition and nucleation and growth mechanism.
- Fabricate the active glass-ceramics based planar waveguide using lithography and laser writing and characterize their spectroscopic properties

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[2] G. Dantelle, M. Mortier, D. Vivien, and G. Patriarche, Influence of Ce3+ doping on the structure and lumines-cence of Er3+ doped transparent glass-ceramics, Opt. Mater., 28 (6) (2006) 638–642
[3] G. Grand, J.P. Jadot, H. Denis, S. Valette, A. Fournier, A.M. Grouillet, Low-loss PECVD silica channel waveguides for optical communications. Electron Lett. 26(25) (1990) 2135-2137.
[4] M. Kawachi, M. Yasu, T. Edahiro, Fabrication of SiO2–TiO2 glass planar optical waveguides by flame hydrolysis deposition. Electron Lett. 19(15) (1983) 583-584.
[5] J.A. Oke, T.C. Jen, Atomic layer deposition and other thin film deposition techniques: from principles to film properties. J Mater Res Technol. 21 (2022) 2481-2514.
[6] P. Chen, X. Wang, Cerium Oxide Film Growth Using Radio-Frequency Sputtering Process. Mater Sci Appl. 11(5) (2020)305-318.
[7] C.J. Brinker and G.W. Scherer, Sol-Gel Science: The Physics and Chemistry of Sol-Gel Processing (Academic, New York, 1990)

Practical information

- Contract will start in October 2025, for 4 years.
- Recruiting institution: Tampere University (Finland)
- Doctoral school: Doctoral Programme in Engineering Sciences
- Industrial mentor: AOI (France)
- Host laboratory: Photonics Laboratory, Tampere University (Finland)
- Supervisor: Prof. Laeticia Petit
- Co-host laboratory: Włodzimierz Trzebiatowski Institute of Low Temperature and Structure Research
- Co-supervisor: Prof. Anna Łukowiak

- Secondments: 1) University of Pardubice (Czech Republic, 3 months) to deposit film using sputtering. 2) Nice Institute of Physics (France, 3 months) to write waveguide using laser irradiation.
- The gross monthly salary based on the MSCA rules varies between 1920€ and 4063€, depending on the country of recruitment.
- The student will also receive a mobility allowance and a family allowance (depending on family situation) of up to 600 € and 495€ per month, respectively.

Recruitment criteria

- MSCA Mobility Rule: researchers must not have resided or carried out their main activity (work, studies, etc.) in the country of the recruiting beneficiary for more than 12 months in the 36 months immediately before their date of recruitment
- All researchers recruited in a DN must be doctoral candidates (i.e. not already in possession of a doctoral degree at the date of the recruitment)
- Possession of a Master's degree before the start date of the contract
- Scientific excellence to fit the PhD project
- Fluent (oral and written) English skills as the project operates in English language
- Team-mindedness

Criteria specific for PhD2

- Good knowledge in materials science - techniques of inorganic materials synthesis and characterization
- Basic knowledge in film technology
- Master degree in Material Science or equivalent with experience in experimental work in chemical laboratory

Application

Documentation to be sent in by the applicants

- Application form completed
- CV + Letter of motivation
- Contact of two reference persons to be contacted by the selection committee (name, relation to the candidate, e-mail address and phone number)
- Complete list of publications and academic works
- Proof of language proficiencies
- Proof of master diploma or 2024 registration to master degree

How to apply?

- Download application form and fill it indicating all the offers you wish to apply for
- Send your application by email to **recruit@functiglass.eu**. The title of your email MUST be :
  FunctiGlass PhD x, x, x application (x, x, x being the number(s) of the PhD position(s)
- you want to apply for)
- Be careful to join all documentation required (see list above)

Deadline for application
15th April 2025

Contact
contact@functiglass.eu