8 PhD Scholarships available

in **physics, chemistry, materials science/engineering, chemical engineering, optical engineering, and mechanical/electrical engineering** in the Photonics Materials and Optical Fibres (PMOF) Group at the Institute of Photonics and Advanced Sensing (IPAS) at the University of Adelaide (UoA).

"Breaking through the manufacturing 'glass ceiling' for ultra-high-purity ZBLAN glass optical fibres for quantum communication and faster internet"

ZBLAN is a special fluoride glass type that has been heralded for overcoming the current limits of fibre optics cables, however small-scale manual manufacturing and insufficient purity have hampered to achieve the potential of ZBLAN optical fibres.

WHY CHOOSE US

UoA

UoA is ranked in the world's top 100 Universities, with its Research Institutes globally recognised for their research quality and collaboration with industry, government and the wider community. UoA is also a member of the Group of Eight and #1 in SA for Graduate Employability.

PhD scholarships

8 PhD scholarships are available within the ARC 4-year research program on developing the next generation of ZBLAN fluoride fibres. The PhD projects span disciplines of physics, chemistry, materials science, and various engineering disciplines. The successful candidates will join the PMOF group, embedded within IPAS, and will also closely collaborate with other research groups within the Faculty of Science, Engineering and Technology. The PMOF group specialises in developing novel optical glasses and fibres for diverse range of application, including ZBLAN glass and fibre fabrication for telecommunication, laser and quantum applications. The group has close connection to research groups in the School of Physics, Chemistry and Earth Sciences; School of Chemical Engineering; and School of Electrical and Mechanical Engineering.

IPAS

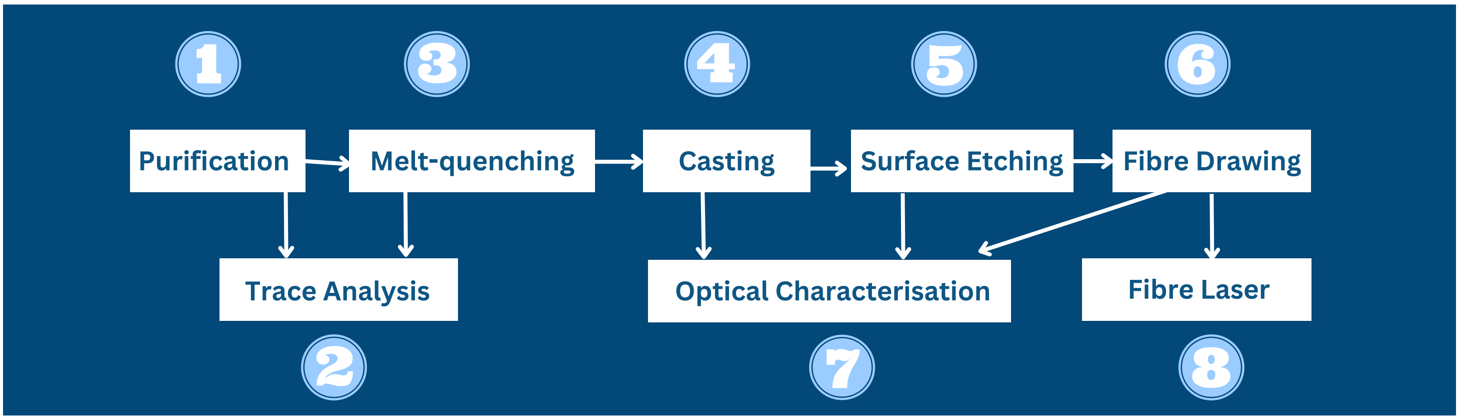
IPAS is a global hub of photonics research at UoA, creating transformational new approaches to sensing and transdisciplinary problem solvers. IPAS has a proven track record of converting partnership investments into successful outcomes to deliver:

"Breakthrough science driving transformational technology for a safer, healthier and wealthier world".

Flawless Photonics

The successful PhD candidates will have opportunities to collaborate with the industry partner of the research program – Flawless Photonics Pty Ltd., who has the world leading expertise and pedigree in **automation** and **space manufacturing**. Flawless Photonics Pty Ltd. identifies and commercialises disruptive, and game changing space technologies developed by research partners globally. Flawless was established by a team of very experienced entrepreneurs in 2017, employs over 30 people and is executing on over $25M in government contracts across geographies. In South Australia, Flawless has developed a strategic collaboration with IPAS.

8 PhD scholarships cover the full ZBLAN manufacturing and characterisation chain:



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CHEMISTRY & ENGINEERING FOCUSED PROJECTS

1 Raw material purification

Impurities in glass making raw materials such as transition metal ions and water lead to reduced transmission of light in the ZBLAN glass preform made from these materials and finally the fibre made from the preform relative to the theoretical limit of the glass. This project aims to advance and innovate purification of raw materials for ZBLAN glass fabrication using processes such as solvent extraction, precipitation, dehydration, sublimation. This project will push the limits of purification efficacy and yield and preventing re-contamination.

2 Ultra-low trace analysis

Monitoring the progress of raw material and glass purification processes requires reliable methods for measurement traces of impurities such as transition metals and water at ultra-low concentration. This project aims to advance elemental analysis of raw materials and glass towards ultra-low detection limits to be able to measure metal impurities in the ppb range for evaluation of raw material purification and any contamination during glass fabrication and fibre drawing.

5 Glass surface etching

Fibre drawing requires surface treatment of the preform to remove any contamination from the surface and to achieve a superior surface finish; both effects are critical to prevent detrimental surface crystallisation during fibre drawing. This project aims to advance and innovate non-aqueous acid and dry plasma etching to achieve a glass surface with the same composition as the glass in the volume and with a roughness close to the theoretical limit. The project is expected to involve anhydrous acid etching and also exploration of the use of plasma etching. The impact of surface quality will be evaluated by analysis of the propagation loss and mechanical strength of the fibres made from the surface treated preforms.

FLUID DYNAMICS AND AUTOMATION ENGINEERING FOCUSED PROJECTS

3 Glass flow model

During glass shaping processes such as casting, extrusion and drawing, glass changes viscosity from liquid or viscous (melt) to solid (preform/fibre), whereby the cooling rate over time is the most critical factor to prevent the formation of detrimental crystals during casting while also avoiding thermal shock induced glass cracking. This project aims to develop and verify a thermal model of the glass shaping processes to predict the effect of various process conditions on the cooling rate of glass and the probability of crystal formation. In addition, the project aims to uncover the impact of gravity to predict and design suitable process condition for glass shaping in microgravity conditions of space.

4 Glass casting automation

Casting of a glass melt into a mould is the most critical process during glass fabrication to prevent detrimental crystal formation in glass. Currently, casting is undertaken as a manual process, which hampers industrial scale fabrication and precise control of the cooling rate during the casting process. This project aims to develop robotics/automation methods to transform the currently fully manual process of glass casting for the first time to a fully automated process, allowing control and reproducibility in cooling rate to achieve consistent quality of preform and hence fibre. Furthermore, adaptation of the casting process and its automation to undertake shaping of molten glass in microgravity conditions of space will be explored.

6 Advanced Fibre drawing technique

Current fibre drawing technology is based on drawing a rod-shaped preform in free space to fibre at elevated temperature, which is a batch-type discontinuous process requiring upscaling of the preform size to upscale manufacturing volume. This project aims to develop an alternative technology for ZBLAN glass - the so-called double crucible technique, where core and cladding glass is fed continuously in a crucible with two compartments for the two glass types, and the glass is drawn from a nozzle into fibre, allowing drawing long-length of fibres. The development of this technique will consider both drawing on Earth in unit gravity and drawing in space under microgravity conditions, which requires research on fluid dynamics and automation.

PHOTONICS FOCUSED PROJECTS

7 Preform and fibre characterisation

Characterisation of preform and fibre for impurities and defects such as transition metal ions and crystals, respectively, is vital for evaluation and improvement of purification efficacy, preform and fibre fabrication. This project aims to develop innovative preform and fibre characterisation methods by combining measurements of impurity content, light propagation loss and glass defects. Furthermore, modelling of the scattering of defects in fibres will be used to gain more insight into the relationship between defect type, morphology and radial location in the fibre cross-section.

8 Fibre laser/Amplifier development

The network of fibre optics cables for data transmission relies on fibres amplifiers to overcome the decrease of signal intensity along the fibre length. Fibre amplifiers utilise the fluorescence of rare earth ions in the glass for the signal amplification. This project aims to investigate the absorption, fluorescence and signal gain behaviours of suitable rare earth ions (erbium, praseodymium, thulium) in ZBLAN glass fibres as the first step towards fibre amplifier and fibre laser development. The project will involve experimental measurements, theoretical calculations and simulations of the dynamics of various electronic transitions within rare earth ions.

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