



**HAL**  
open science

## Silver photochemical reactivity under electronic irradiation analysis of gallo-phosphate glasses

Fouad Alassani, Nadège Ollier, Yannick Petit, Thierry Cardinal, Nadège Ollier

► **To cite this version:**

Fouad Alassani, Nadège Ollier, Yannick Petit, Thierry Cardinal, Nadège Ollier. Silver photochemical reactivity under electronic irradiation analysis of gallo-phosphate glasses. PNCS16 - 16th International Conference on the Physics of Non-Crystalline Solids, Jul 2022, Canterbury, United Kingdom. . hal-04574655

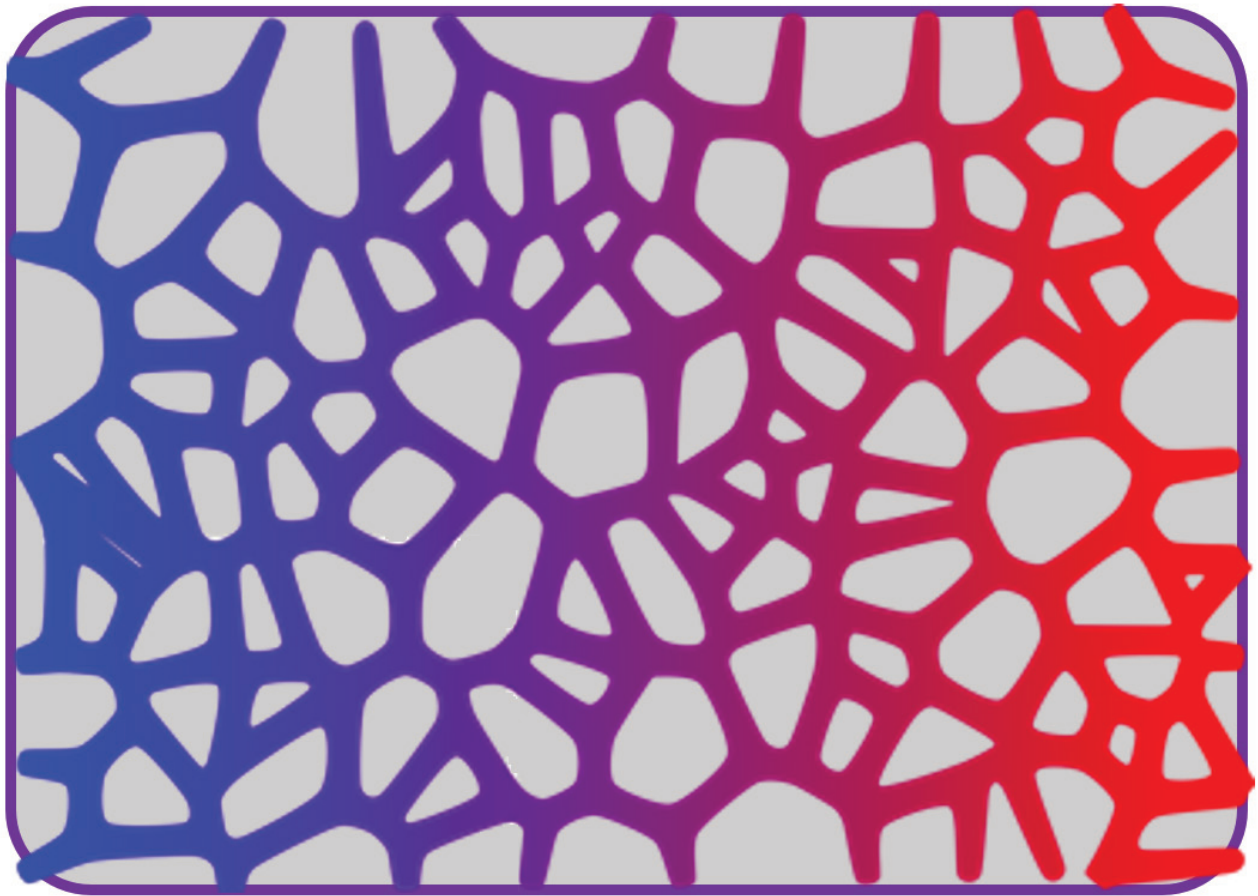
**HAL Id: hal-04574655**

**<https://hal.science/hal-04574655>**

Submitted on 14 May 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



# **PNCS16**

## **CANTERBURY 2022**

### **PROGRAMME AND ABSTRACTS**

**16th International Conference on the  
Physics of Non-Crystalline Solids**

**University of Kent, Canterbury**

**10–15 July 2022**



# 16th International Conference on the Physics of Non-Crystalline Solids

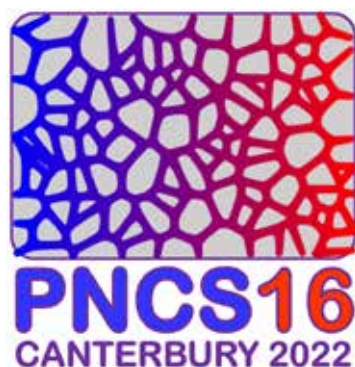
University of Kent, Canterbury

10–15 July 2022

## Programme

and

## Abstracts



### Sponsors

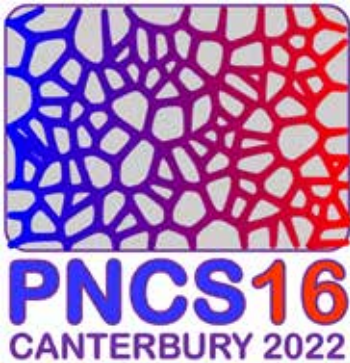


ISIS Neutron and  
Muon Source



**16th International Conference on the Physics of Non-Crystalline Solids**  
University of Kent, Canterbury, UK. 10–15 July 2022. Programme and Abstracts

Conference co-chairs Alex C. Hannon and Gavin Mountjoy



The PNCS16 logo is adapted from the image file "Voronoi.png" by author "LouLB" under the Creative Commons Attribution-Share Alike 4.0 International license (link to original: <https://commons.wikimedia.org/wiki/File:Voronoi.png>). There is no suggestion that the licensor endorses this use.



Society of Glass Technology

9 Churchill Way  
Chapelton  
Sheffield S35 2PY, UK  
Tel +44(0)114 263 4455  
Email [info@sgt.org](mailto:info@sgt.org)  
Web [www.sgt.org](http://www.sgt.org)



2022 is the United Nations International Year of Glass  
[www.iyog2022.org](http://www.iyog2022.org)

# Silver photochemical reactivity under electronic irradiation analysis of gallo-phosphate glasses

Fouad Alassani,<sup>1</sup> Yannick Petit,<sup>1,2</sup> Thierry Cardinal<sup>1</sup> & Nadège Ollier<sup>3</sup>

<sup>1</sup>University Bordeaux, ICMCB, UPR 9048, F-33600 Pessac, France

<sup>2</sup>University of Bordeaux, CNRS, CELIA, UMR 5107, 33405 Talence Cedex, France

<sup>3</sup>Laboratoire des Solides Irradiés, UMR 7642 CEA-CNRS-Ecole Polytechnique, Palaiseau, France

Corresponding author email: [nadege.ollier@polytechnique.edu](mailto:nadege.ollier@polytechnique.edu)

Nowadays photonics is becoming a key enable technology for the future thanks to its ubiquity in a vast spectrum of disciplines. The development of new functionalities in integrated phonic circuits remains highly challenging in order to push photonics technology out of its limit, up to a mature level for industrial transfer. In this framework, the development of innovative materials suitable for integrated circuits as well as laser processing facility are of crucial importance. Indeed, the ability to use direct laser writing for shaping and inscribing functionality in glass material has open a way for the versatile production of multi-scale subwavelength photonic architectures. Recently we demonstrated the possibility to create multi-scale 3D architecture with highly localized fluorescence contrast in photosensitive silver-containing Gallo-phosphate glasses by means of all-optical femto-second laser writing<sup>(1)</sup> However, the understanding of the photochemical phenomena allowing the formation of the silver clusters, which are at the origin of the fluorescence in the Gallo-phosphate glass remains unclear. Indeed, femtosecond laser interaction with glass creates highly out-of-equilibrium free electrons that allow for the activation of silver-based photo-chemistry and associated local material modifications at the root of high optical contrasts both for linear and nonlinear optical properties. In this framework, it is highly interesting to perform high-energy ionizing irradiation to access the initial mechanisms of material modification, and thus to provide the fundamental understanding of the material parameters that play a role in glass photosensitivity.

In the present work, we performed electronic irradiations followed by EPR spectroscopy. This allowed us to demonstrate the process involved in the interaction of electron beam with both the silver-containing and silver-free glass matrices. This allowed understanding the initial phenomena of electron deposition and charge trapping that support the photosensitivity of these glasses by identifying the point defects and the Ag species, which are formed. The in-situ cathodoluminescence measurements gives additional valuable information about the cascade of chemical reactions in the formation of new silver species, namely from the initial silver ions to the molecular silver clusters.

1. Guérineau, T., Loi, L., Petit, Y., Danto, S., Canioni, L. & Cardinal, T. Structural influence on the femtosecond laser ability to create fluorescent patterns in silver-containing sodium-gallium phosphate glasses. *Opt. Mater. Expr.*, 2018, **8**(12), 3748–3760.
2. Guérineau, T., Cova, F., Petit, Y., Abou Khalil, A., Fargues, A., Dussauze, M., Danto, S., Vedda, A., Canioni, L. & Cardinal, T. Silver centers luminescence in phosphate glasses subjected to X-Rays or combined X-rays and femtosecond laser exposure. *Int. J. Appl. Glass Sci.*, .