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## **3D localization beyond diffraction limit of near-IR emission excited by resonant energy transfers from silver clusters in phosphate glasses**

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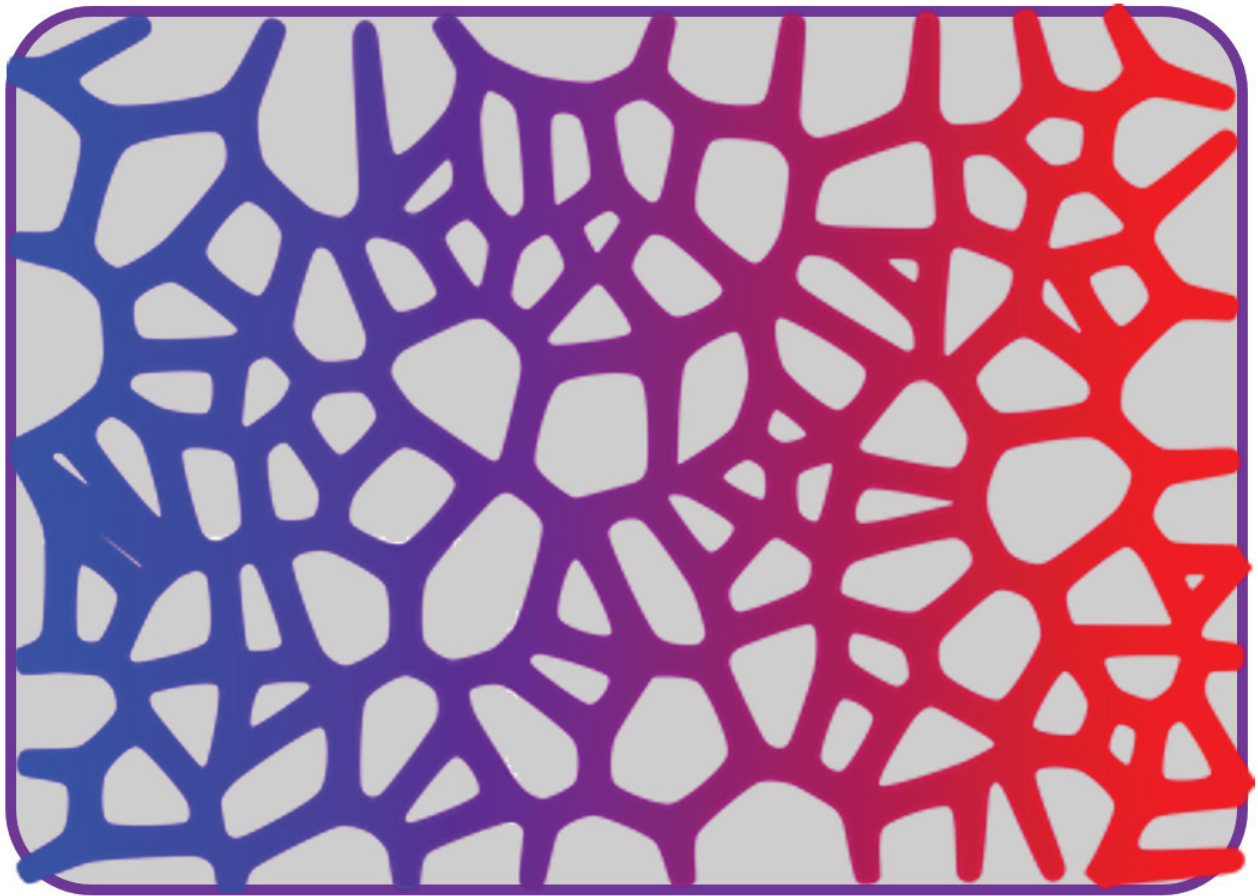
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**University of Kent, Canterbury**

**10–15 July 2022**



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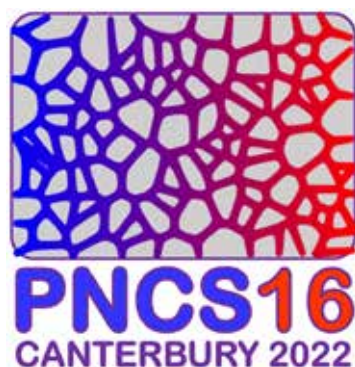
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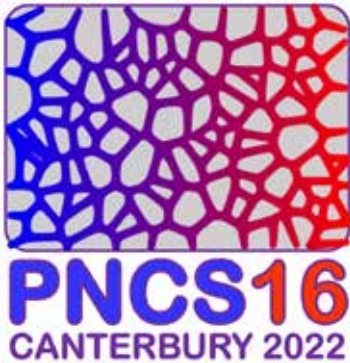


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**16th International Conference on the Physics of Non-Crystalline Solids**  
University of Kent, Canterbury, UK. 10–15 July 2022. Programme and Abstracts

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# 3D localization beyond diffraction limit of near-IR emission excited by resonant energy transfers from silver clusters in phosphate glasses

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Photonics is a key enabling technology thanks to its wide application in many industrial fields. Femtosecond (fs) Direct Laser Writing (DLW) already plays a major role because it is flexible, fast, cost-effective, highly transferable to industrial processes and because it enables highly-integrated optical functionalities and photonic integrated circuits (PIC). Nowadays, there is a growing demand for developing all-optical approaches to create 3D multi-scale architectures with sub-wavelength dimensions for different sectors of the economy. Recently, we developed new expertise in fabricating multi-scale photonic architectures using all-optical fs laser writing in specialty-designed photosensitive silver-containing glasses. One of the challenges relies on the capability of structuring the local luminescent properties. Femtosecond DLW in silver-containing glasses allows for the local creation of an elementary brick with inner features below the diffraction limit.<sup>(1)</sup> Such a modification is composed of highly luminescent silver clusters that result from the migration and chemical reactivity of silver elements, these clusters emitting in the whole visible range. Luminescence, local chemical analysis, and structural properties by vibrational spectroscopy have been carried out in order to clarify the structure/property relationship and the impact of the glass matrix. It clearly appears that the all-optical structuration is highly dependent on the glass host, the silver species environment in the pristine glass, and the DLW parameters.<sup>(2)</sup> We recently demonstrated that co-doping with ions such as rare earth (Eu<sup>3+</sup>, Yb<sup>3+</sup>) allows for tuning the luminescence emission spectrum thanks to the production of highly-localized 3D fluorescence structures of rare-earth ions showing high optical contrast.<sup>(3)</sup> The ability to use laser-inscribed silver cluster structures as templates exhibiting high absorption starting from the UV until 530 nm, leads to local high luminescence with different colors, from the visible to IR range. The efficient non-radiative transfer mechanism operating between the silver clusters and the emitting ions will be discussed, including experimental evidences from confocal hyper-spectral lifetime-resolved imaging.

Indeed, the unique combination of fs DLW in adapted photosensitive glass allows for the fabrication of 3D architectures with sub-diffraction high luminescence contrast. The obtained results offer a unique opportunity for developing robust 3D integrated photonic components in which the emission spectrum can be adapted. These findings will offer new opportunities for the development of high-precision fluorescent optical integrated components in the red/near-infrared range for health and life sciences for instance.

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