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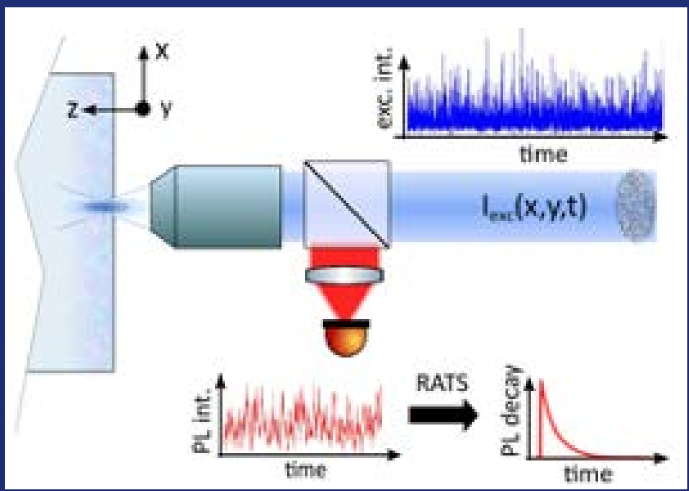
Project title:

# Tomography of Defects in Optical Materials Using 3D Structured Light

'Optical materials' is a phrase commonly used for materials employed in the production of optical elements, such as lenses, mirrors, etc. In these materials, defects may be caused either during the actual preparation of the material—for instance, due to absorption additives in the glass—or they may appear close to the surface during processing of the material. In both cases, these defects are a factor which sets the limits for the usage of the resulting elements, e.g., for strong laser beams or in harsh environments.

Tomography of defects, i.e., their 3D mapping, is crucial for understanding the reasons of the appearance of particular defects. At the present time, however, it can only be achieved by means of confocal microscopy, which is a relatively time-consuming method requiring sequential scanning of the entire volume of the material. Moreover, a confocal microscope is a relatively costly instrument.



This project explores a completely new approach to tomography using the principle of the so-called single-pixel camera to examine the photoluminescence (PL) of the defects. PL is a light characteristic of a given defect, which the defect emits when exposed to short-wave (typically UV) radiation. The spectrum and shape of the PL extinction is a clue that reliably leads to the detection of the type of the defect.

The aim of the project is to create a new way of generating random 3D patterns which will facilitate efficient spatial mapping of PL samples and thus will help us to determine, with great precision, the distribution of defects in the material. Unlike sequential image scanning, this method will make it possible to measure the information from the entire area of interest simultaneously. A random 3D pattern can be obtained around the focal plane of a lens using random modulation of the light wavefront. Apart from creating these patterns experimentally, we will also describe them computationally.

The overall result will be a PL microscope which will help us to better study the defects arising in optical elements during their processing. Finally, we may be able to better understand the origin of these defects and to learn to prevent them.

## Expected results and outcomes of the project

- New method for generating 3D random light patterns for precision spatial tomography
- Photoluminescence microscope for 3D tomography of defects in optical materials
- Deeper understanding of the origin of surface defects during material processing

## International cooperation

*Chemical Physics Department, Lund University, Sweden.*

Above all, this cooperation concentrates on exploring the application of materials tomography to a wider range of materials, e.g., halide-perovskite samples.

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