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ASSESSMENT OF A PHOTOSENSITIVE SOL-GEL AS A SPACE READY MATERIAL THROUGH THE RECORDING OF HOLOGRAPHIC OPTICAL ELEMENTS.

Abstract

Wavefront sensors (WFS) are a vital piece of the many adaptive optics systems allowing for accurate imaging of the night sky, optical communications and medical imaging. A Holographic wavefront sensor (HWFS) is a novel class WFS that has emerged in recent years for use in adaptive optics. With the application of space in mind the performance is not the only factor we have to consider. With thousands of satellites and CubeSats being launched to orbit each year, the weight and robustness of the payload are crucial. This paper looks at the potential of a fast curing, water resistant, photosensitive sol-gel material as an alternative to traditional photosensitive materials used in holography. This is done by recording several slanted volume-phase transmission holograms at 532 nm, to analyse the impact that shrinkage and 'dark processes' have on the hologram's efficiency and reconstruction angle, over extended periods of time. A bio-convex lens was used to record the first Holographic Optical Element (HOE) in this material. Material shrinkage was observed in an extremely short time-period (<5 minutes) post recording. The effect on the hologram's efficiency, spatial frequency distribution and reconstruction angle were apparent through post recording analysis using a single beam exposure. The paper also investigates a possible solution to bleach the sol-gel, hoping to prevent or minimise the impact of such processes. Further work will involve recording with different refractive lenses and using angular multiplexing techniques, to facilitate wavefront aberration measurements. The project proved to be a significant advancement in knowledge in a relatively unstudied material, for an extremely versatile application. The reduction in weight and the inexpensive production could pave a new way of developing highly accurate, robust, light weight and cost-effective HWFS for furthering space exploration as we know it.