LOW COHERENCE SPECKLE INTERFEROMETRY (LCSI) – A TOOL FOR DEPTH RESOLVED DEFORMATION MEASUREMENTS

Gerd Gülker
Institute of Physics, Carl von Ossietzky University Oldenburg, 26111 Oldenburg, Germany
E-mail: gerd.guelker@uni-oldenburg.de

In recent years electronic speckle pattern interferometry (ESPI), has become a powerful tool in the real-time observation of object vibrations and micro-deformations. Since a long time our group uses this technique e.g. for the investigation of deterioration processes in works of art and for the development of procedures for their preservation.[1]

One very exciting application of the method was the monitoring of deformations on coloured fragments of the famous 2000-yrs-old terracotta army of the first Chinese emperor. One problem in the preservation of these objects is that the multilayered colour, which partly exists on the terracotta, is very fragile. They show immense sensibility to humidity changes and since the excavation led to a desiccation of the terracotta figures, the remnants of the paint layers were extremely endangered to fall off. In order to develop suitable methods of conservation ESPI measurements were performed during cycles of humidity changes to estimate the influence and suitability of several conservation agents and procedures.

During the investigations we realized that it is of great interest to measure the behaviour of the individual layers of the multi layered painting separately. For this purpose, a modified ESPI system was designed with a low-coherent superluminescent diode (SLD) instead of a laser. By changing the path length of one of the interfering beams it is thus possible to select a region limited in depth where deformations should be measured even if it is located below the surface. The use of well adapted evaluation procedures like spatial phase shifting in combination with the Fourier transform method allows the separation of the coherent from the incoherent part of the reflected light, which is very helpful for a reliable evaluation of the deformation maps.

The basic of this modified LCSI method is the measuring of the echo time delay and magnitude of backscattered light and one well-known representative of this technique is optical coherence tomography (OCT). Typically, the latter method is used to get cross-sectional topographic images from the internal microstructure in materials and biological systems. In contrast to these applications our aim is not (only) to get absolute topographic information about the internal structure but to measure their deformations.

In this contribution the modified system will be presented and some deformation measurements on an artificial test object and on terracotta fragments will be demonstrated.

1. K. D. Hinsch, G. Gülker, H. Helmers, “Checkup for aging artwork: optical tools to monitor mechanical behaviour”, *Opt. Laser Eng.* **45**, 578-588 (2007)