Introduction

The mechanical stability of the optical components used in optical measurements is regarded as crucial, since even the smallest drift or disturbance can be influenced in the results of an optical measurement. Commercial mounts are widely used in laboratories because accuracy and reliability in ensuring stability are provided, but their high cost makes them difficult to be obtained for educational purposes and budget-limited research environments. With the growing and easy accessibility of desktop 3D printing, the making of custom optical mounts at a much lower cost has become possible.

Yet it is still unclear how these printed parts perform in practice under the influence of disturbances such as thermal or mechanical effects compared to commercial mounts. To measure and analyze stability of mechanical parts (commercial and 3D printed) under identical conditions, the Michelson interferometer is employed in this thesis as the tool. Because of its high sensitivity to very small changes and its ability to react to even minimal disturbances, an effective means of comparing the phase stability performance of different types of optical mounts and post holders is provided by the Michelson interferometer. A custom-built GUI is used to monitor and analyze the stability in real time, and objective measurements rather than assumptions are ensured as the basis of the results. The objective of this thesis is defined as the comparison of the stability of the optical post holders and mounts using a Michelson interferometer across several configurations with a reference setup under the same testing conditions. The results of the analyses can be used to help determine the reliability of using 3D-printed mounts in sensitive optical experiments. Such findings are regarded as relevant for situations where customized, low-cost optical components are needed. To mention that ‘Optic Cubes’ (UC2) were developed at the Leibniz Institute of Photonic Technology (IPHT), Jena, as a low-cost, 3D-printed, open modular microscopy toolbox [1]. They were later used in education and adapted with improvements and extensions in [2]. This thesis is structured as follows.

The theoretical background of the thesis is discussed in Chapter 2, the basics of light as an electromagnetic wave are explained, and the principles of the Michelson interferometer with its components are described. Principles of interference, coherence of light and its importance in the Michelson interferometer are also explained. The methods used in this thesis to measure and analyze the stability are presented, as well as the basics of 3D printing.

Chapter 3 describes the methodology, including the experimental setup, the video acquisition and analysis methods implemented in the GUI, calibration procedures used in this thesis.

Chapter 4 is presented as the results and analysis for each experimental setup compared to the reference setup.

Chapter 5 summarizes the conclusions drawn from the findings, challenges encountered are talked about, and ideas for further research are suggested.