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A method to improve the stability of the optical interference system

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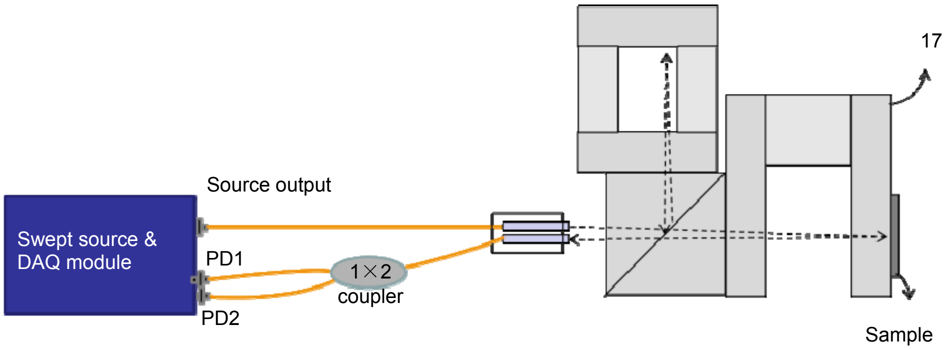

Schematic diagram of the interference measurement system.

Abstract: The measurement system based on optical interference has obvious advantages of high precision and high sensitivity. However, the signal is easy to be disturbed by vibration from environment, so the system needs to stay away from the vibration source. To use the optical interference method for real-time measurement, it has to improve the system's stability. We proposed an integrated Michelson interference device to measure the thicknesses of multiple layers of optical plate, which could improve the stability of the optical interference system in a new way. Optical cement is used to splice the glass modules, which could eliminate the influence of the glue. The material with low thermal expansion coefficient was used in a symmetrical structure, so that the device can make compensation to the environmental temperature variation. And the input and output ports were welded into the packaging box. Through these smart design and high precision processing technique, the light path of the structure was integrated into a whole, so the device won't be disturbed by the environment compared to the other interferometers during measurement. To test the stability of the device, a low coherent interferometry system was introduced, and an interferogram with ~3 kHz speed was acquired. Compared with a fiber based interferometer, it was found that our system had obviously more stable signal. We also used the low coherent interferometry system to demonstrate the method of multiple layers measurement, and the principle was given. The broadband light source is used as the input, the signals reflected from sample and the reference beams were combined and the output interference signal was exported to a synchronous acquisition system. And then the fast Fourier transform algorithm was used to analyze the interference signal. The precision of our low coherent interferometry system was 8.57 μm, and the measurement range was 5 mm in air. Finally, the thicknesses of a glass slide and a stack of two cover glasses were measured to confirm its feasibility to do the real-time measurement. The measured thickness of the glass slide was 2230.8 μm, the two cover glasses were 181.6 μm and 175.1 μm, respectively. The measurement was comparable with the commercial thickness measurement equipment. The results by high precision imaging measuring instrument VMS-1510 were 2225 μm, 178 μm and 173 μm, respectively. And the results from micrometer were 2221 μm, 172 μm and 170 μm, respectively. Furthermore, we could also give the thickness of the air gap between the two cover glasses, which was 19.6 μm. In summary, we believe this device and method will be helpful for the real-time interference measurement of multiple layers of optical plates.

Keywords: optical device; real time measurement; optical interference; anti-interference; thickness measurement

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