Compensation of the thermal conditions influence on the profilometric surface asperities measurements

Abstract

The doctoral thesis presents the issues related to thermal aspects and their impact on stereometric measurements of surface irregularities with the use of contact profilometers. Analyses of the influence of internal heat sources originating from the drives of profilometers and electronic subassemblies were carried out, as well as the influence of temperature changes of the environment of the measuring device during the measurements. It is worth mentioning that contact surface topography measurements are commonly used in industry, where the assurance of stable measurement conditions is limited. The paper focuses on determining the influence of thermal reactions on the construction of profilometers, as well as the validity of temperature control in research rooms.

The theoretical part of the dissertation presents the division of devices for surface topography measurements. The contact and selected non-contact measuring techniques together with specification of the disadvantages and advantages of each method were discussed. The attention was focused on contact profilometers, presenting the issues including their structure and the principle of operation. The dissertation addresses problems related to long-term spatial measurements of the surface and solutions were proposed to improve the metrological properties of this group of devices.

In the further part of the work, the focus is on the thermal analysis discussed in the chapter 7 of the structure. Static characteristics of the used measuring apparatus are presented and the construction of the thermal chamber enabling the control of the temperature of environment of the profilometer is described (chapter 8).
The chapters (7.1 and 7.4) present the research methodology including static tests for internal heat sources and dynamic for changes in the environment temperature of the measuring machine.

Analyses of the received data were carried out and solutions were proposed to limit the influence of temperature on profilometric measurements of surface topography. The result of these activities was the creation of software with an implemented correction algorithm that reduces the effect of both internal heat sources and external fluctuations in the temperature of environment of the profilometer. The methodology for determining

the necessary correction parameters was described. Additionally, the time of thermal stabilization of selected structures of profilometers was determined and the time after which the surface unevenness should be measured was specified.

The final result of the work was a comparison of the test results including surfaces with visible disturbances as a result of thermal influence with the surfaces after the correction of the temperature impact. The influence of material properties of the tested sampleon the resultant thermal expansion of the whole measuring path was presented.

Based on the analysis of literature and own research, cognitive and utilitarian conclusions regarding the described issues were formulated. Studies have shown that there is a relationship between temperature changes and the mapping of the tested surface. This is confirmed by the displacement values of the measuring head of the profilometer in the Z axis determined by an independent method of laser interferometry.

Understanding the phenomena and dependences raised in the dissertation is important in the correctness of mapping of real surfaces and determining their parameters. Knowledge of the occurring effects will contribute to improving the structure and metrological properties of contact profilometers.