New approaches in ultra precision manufacturing of diffraction gratings

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Abstract

Regarding the production of diffraction gratings, there are complementary, partly competing processes. Besides various specific methods, which play a minor role, interference lithography (IFL) and mechanical manufacturing are established. Both methods have application specific characteristics.

Mechanical processes are criticized for having higher scattered light and ghost intensities. IFL are characterized by the option of aberration correction by varied line spacing (VLS). The structure results from interfering waves and is not necessarily known.

State-of-the-art mechanical manufacturing is achieved by ultra-precision-machining (UP). The production has the highest demands disturbance control, especially regarding processes that are sensitive to false light phenomena, such as Raman-spectroscopy. Using control compensation and the machine's degrees of freedom, the existing disadvantages can be eliminated and the advantages of IFL can be exploited. By compensating cyclical errors of glass scales, false light phenomena can be eliminated.

In recent years it has been shown that UP-techniques suitable to produce high quality gratings with strong curvature, which are hardly achievable by other methods. Such gratings are used in compact spectrometers nowadays

Additional, UP-manufactured gratings have the possibility to manufacture VLS-gratings. With trajectories that are neither linear nor equidistant, improved imaging properties can be achieved for selected diffraction orders, even on plane gratings. The investigation of the production of such gratings is part of the current research. Contrary to the IFL structures resulting from interference in a complex optical setup, the the geometrical parameters are calculated by phase functions.

The direct production of metallic masters enables the replication, which is state-of-the-art for plane masters. Research work is currently being carried out on the replication of curved masters. A remaining problem is the dimensional measurement of such surfaces. Because the structure cannot be recorded in its entirety and has a different structure at each position, only the optical function can be recorded.

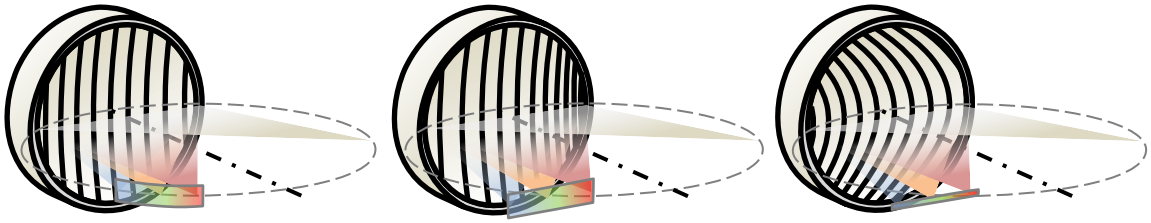

Figure 1: a.) linear and equidistant, b.) linear not equidistant c.) neither linear nor equidistant