The Nanometer Optical Component Measuring Machine

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Abstract. The Nanometer Optical component measuring Machine (NOM) has been developed at BESSY for inspection of the surface figures of grazing incidence optical components up to 1.2 m in length as in synchrotron radiation beam lines. It is possible to acquire information about slope and height deviations and the radius of curvature of a sample in the form of line scans and in a three dimensional display format. For plane surfaces the estimated root mean square measuring uncertainty of the NOM is in the range of 0.01arcsec. The engineering conception, the design of the NOM and the first measurements are discussed in detail.

11.1 Engineering Conception and Design

The nanometer optical component measuring machine (NOM) (Fig. 11.1) was developed at BESSY for the purpose of measuring the surface figure of optical components up to 1.2 m in length used at grazing incidence in synchrotron radiation beamlines [1–3]. With it, it is possible to determine slope and height deviations from an ideal surface and the radius of curvature of a sample in the form of line scans and in a three-dimensional display format. With the NOM surfaces, up to 600 cm$^2$ have been measured with an estimated measuring uncertainty in the range of 0.05μrad rms and with a high reproducibility. This is a five- to tenfold improvement over the previous state of the art of surface measuring techniques such as achieved using the Long Trace Profiler (LTP-II) [3,4]. The NOM is basically a hybrid of two angle measuring sensor units, a Long Trace Profiler (LTP-III) and a modified high resolution autocollimating telescope (ACT). The latter (ACT) has been developed with a very small aperture of about $d = 2$ mm [1] (Fig. 11.2). The measuring principle of both sensors is noncontact deflectometry. In both cases, no reference surface is needed. The LTP III head is a BESSY-specified development by Ocean Optics Ltd. in cooperation with Peter Takacs (BNL) who created the optical design. The autocollimator used is a special development by Möller Wedel Optical GmbH. The two sensors are mounted stationary and opposite to each other on a compact stone base (Fig. 11.2) [1,3]. The two test beams are adjusted in a
Fig. 11.1. The nano optic measuring machine NOM at BESSY. To insure stable environmental conditions the instrument is enclosed in a double walled housing.

straight line to each other and are guided by a pentaprisim or double reflectors to and from the specimen. The influence of the pitch tilt on the measurement is compensated for by the 45°-pentaprisim design. The reflector unit is mounted on a movable air-bearing carriage system on the upper member of the stone frame. It consists of two parts: (a) one carriage for the motor, which is linked