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Manufacturing of single crystal Molybdenum mirrors for ITER diagnostics

W. Vliegenthart, B. van Venrooy, C. van Drunen, B. den Dulk, P. van Doorn.
TNO Science & Industry, PO box 155, 2600 AD Delft, The Netherlands

Abstract
Over the past few years TNO has put a significant effort on specific topics for ITER diagnostics such as Molybdenum mirror manufacturing, mirror cleaning, diagnostic shutters and radiation hardened fibres.
Single crystal Molybdenum is because of its high radiation resistance, the candidate material for many of the ITER first mirrors. Flat and spherical mirrors can be manufactured with classical optical workshop technologies. Considerably good results were obtained on flat surfaces (Rq better than 1 nanometer). Manufacturing of aspherical mirrors from single crystal Molybdenum is not trivial and requires a different approach. Conventional tooling such as a lathe or grinder, will not allow high precision machining of single crystal Molybdenum. A diamond turning lathe equipped with a grinding tool has been used for manufacturing the mirror. One of the main challenges that have been faced is how to solve the problem of tool wear. Tool wear limits the final accuracy of the mirror.
The first precision grinding experiments were performed on small 30 mm single crystal samples of Molybdenum (111) and Tungsten (111). Erosion experiments that have been performed in Textor on concave mirrors revealed that no surface damage occurred.
Grinding experiments were continued on 100mm diameter Mo samples (111) and (110) orientation.
Secondly, CNC polishing technology has been developed on the 100 mm Molybdenum substrates. The main advantage of CNC technology in this respect is that it allows corrective polishing on specific parts of the mirror.
The extensive development program has resulted in a reproducible generic manufacturing process for high quality single crystal Molybdenum mirrors. The process is suitable for manufacturing aspherical optics. For demonstration two 10 cm concave SC Molybdenum mirrors have been produced within the required optical quality.
An overview of the process development, measurement technologies and the mirror prototypes will be presented at the conference.

Keywords: Molybdenum, mirror, single crystal, optical diagnostics, ITER,

Corresponding Author:

Willem Vliegenthart
TNO Science and Industry
Department Space and Science
PO BOX 155
2600 AD DELFT
The Netherlands
willem.vliegenthart@tno.nl