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Preparation and characterization of X-ray mirrors and development of thin-film metamaterials for thermal photovoltaics

Michael Stormer
Helmholtz-Zentrum Geesthacht, Institute of Materials Research, Germany

Magnetron sputtering is a versatile tool to synthesize nanocrystalline or amorphous phases with well-adapted material properties. This thin-film method enables us to coat very precisely, uniform and flexible. High surface quality is required in a variety of technical applications, such as architectural glass, metallic surfaces and especially for X-ray mirrors. Another advantage is that it is applicable to materials with a very high melting point, which opens the use of refractory metals. This presentation will focus on two research fields, which exploit the mentioned advantages for thin-film preparation of X-ray mirrors and thermophotovoltaic metamaterials. Large X-ray mirrors are required for beam transport at free-electron lasers (FELs) and synchrotron sources worldwide. The demand for large mirrors with lengths up to 1m single layers and multilayers consisting of light or heavy elements has increased during the last few decades. At the Helmholtz-Zentrum Geesthacht (HZG), a 4.5m-long sputtering facility enables us to deposit a desired single-layer material some tens of nanometers thick. For the European XFEL project, the shape error should be less than 2nm over the whole 1m X-ray mirror length to ensure the safe and efficient delivery of X-ray beams to the scientific instruments. The challenge is to achieve thin-film deposition without any change in mirror shape. Magnetron-sputtered thermophotovoltaic metamaterials are synthesized to obtain a selective thermal emitter. We demonstrated the high-temperature stability of W/HfO_2 metamaterials till 1000°C. The experimental results achieved will be discussed with regard to current restrictions and future developments.

michael.stoermer@hzg.de

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