Testing of Reflective Quarter-Wave Retarder in EUV Range

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Abstract

There has been an increasing demand to understand the optical, electronic, and structure properties of materials at shorter wavelengths in the far ultraviolet (FUV) and extreme ultraviolet (EUV) range. This has pushed researchers to examine and outline new optical devices as quarter wave retarder (QWR) which, coupled with other techniques, can provide valuable information about physical and optical properties of materials[1].

Aluminum is a decent hopeful material that has been used for quite a while for multilayer optical tools in the FUV-EUV range because of its high reflectivity performances. Several studies have been done to use quarter-wave retarders based on a single layer of aluminum reflective coatings[2]. However, for wavelengths shorter than 160 nm the presence of aluminum oxide Al_2O_3 due to the strong reaction with air strongly influences the optical properties of the film. The oxide layer has very high absorption in vacuum ultraviolet range reducing the reflectance of the aluminum in this region. [3] Then some protective cap layer structure is required to avoid oxidation without affecting the resulting performances.

For that purpose, we investigated the polarization properties of reflective EUV polarimetric apparatus based on Al layer structure as a quarter-wave retarder (QWR) with a protective capping layer to avoid oxidation and contamination to improve stability and reflectivity efficiency. This device works within a suitably wide spectral range (88-160 nm) where some important spectral emission lines are as the hydrogen Lyman alpha 121.6 and Oxygen VI (103.2 nm) lines. The structure was characterized by performing reflectivity measurements with s- and p-polarized light as a function of the wavelengths for different incidence angles. In addition, the phase retardance on reflection was determined however, it is not an easy task to characterize the phase delay. Previously, common methods for measuring the phase shift of an optical tools are using interferometric techniques [4]. But in the EUV, these procedures are constrained frequently to work at small grazing incidence or a narrow bandwidth. At this time, a commonly used method in the EUV ML characterization is based on the photoemission analyses obtained via Total Electrons Yield (TEY) measurements combined to reflectance estimations to test the standing wave on the surface of a multilayer film. [5].

Such design could be particularly useful as diagnostic tools in EUV-ellipsometry field. The system can be a relatively simple alternative to Large Scale Facilities and can be applied to test optical components by deriving their efficiency and their phase effect, i.e. determining the Mueller Matrix terms, and even to the analysis of optical surface and interface properties of thin films. In addition, the phase retarder element could be used in other experimental applications for generating EUV radiation beams of suitable polarization or for their characterization.

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