High reflectance FUV narrowband mirrors

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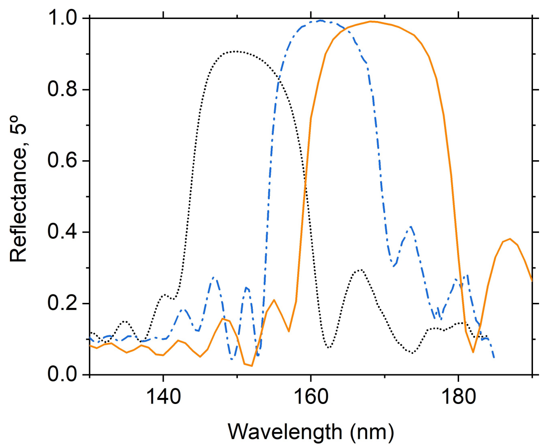
The development of efficient dielectric coatings in the far UV (FUV) is demanded for upcoming space instrumentation, such as LUMOS (LUVOIR Ultraviolet Multi-Object Spectrograph) in the proposed NASA-LUVOIR mission, among other applications, which include petawatt-laser beamlines, excimer laser optics, high-order harmonics, thermonuclear fusion reactors, or the semiconductor industry.



Narrowband FUV coatings can be prepared with all-dielectric multilayers (MLs) based on two fluorides. The relatively higher expansion coefficient of fluorides in comparison with common substrates such as fused silica (FS) or Zerodur®, results in large tensile stress for coatings deposited on a heated substrate and later cooled down to room temperature. Such stress may result in coating cracking and/or delamination in a process that grows with the number of layers.

We present a comparison between AlF_3/LaF_3 and MgF_2/LaF_3 FUV MLs prepared by thermal evaporation. We evaluated the FUV reflectance over time, stress, roughness, the influence of substrate materials, and also the role of the deposition and post-deposition temperature on the aforementioned parameters. FUV reflectance of 0.99 at ~160 nm was obtained with both combinations of fluorides. While $(AlF_3/LaF_3)^m$ MLs tend to keep their high reflectivities after almost a year of ageing, $(MgF_2/LaF_3)^m$MLs decayed more. Both types of MLs shifted about ~3 nm towards longer wavelengths over time. FWHM of (AlF_3/LaF_3) ML coatings is about 3 nm larger than for (MgF_2/LaF_3) ones, which is attributed to a smaller refractive index of AlF_3compared with MgF_2. These differences in FWHM can be taken advantage of for specific bandwidth requirements.

MLs with AlF_3 grow with smaller stress than MLs with MgF_2. Consequently, hot-deposited (AlF_3/LaF_3) MLs tolerate a higher total thickness than (MgF_2/LaF_3) MLs before cracks are generated. Additionally, an effective way to decrease stress on fluoride coatings, and thus, enable higher deposition temperatures or more bilayers, is the use of a substrate with a similar CTE to the coating, such as CaF_2, Borosilicate BK7, or quartz, instead of low CTE materials, like FS.