

Observing the sun at short wavelengths – Optical coatings for the solar telescopes MUSE and EUVST

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Astronomical spectroscopy is an indispensable tool for probing the physical and chemical properties of celestial objects. When moving from the infrared and the detection of molecular vibrations and rotations towards the visible spectral range and the observation of characteristic gas absorption lines, the increased energy at even shorter wavelengths in the extreme ultraviolet (EUV) spectral range allows for the detection of emission lines from highly ionized atoms. This is ideal when observing the sun, as these highly ionized states only occur, if sufficiently high temperatures are reached, making EUV-spectroscopy a perfect temperature probe that can handle millions of degrees Kelvin.

The talk will focus on the two solar telescopes: MUSE (Multi-slit solar explorer) and EUVST (EUV High-throughput Spectroscopic Telescope) that are planned for launch in 2027 and 2029, respectively. The scientific aim of both solar missions is to gain a deep understanding of the physical processes that drive the heating of the sun's hot atmosphere as well as the physical processes involved in space weather events like flares and coronal mass ejections, which have a direct impact on our modern infrastructure (e.g. satellites, power grids, GPS accuracy, etc.).

Even though both satellites will share in part the same spectroscopic information, the approach is different and thus highly complementary. This leads to fundamentally different requirements on the optical coatings for the mirrors and gratings: EUVST is designed as a single-slit spectrograph covering a very broad temperature range of emission lines, which requires a broadband aperiodic EUV multilayer design. MUSE on the other hand is designed as a multi-slit spectrograph with a large field of view at a cadence of just 12 seconds to, for the first time, fully capture the rapid temporal evolution of large-scale coronal events under the slit(s) of a spectrograph. This requires multi-channel, extreme narrowband coatings to avoid spectral crosstalk.

At optiX fab, we successfully coated the flight hardware for both solar telescopes this year. Besides the challenging spectral reflectance requirements, the talk will address mechanical and coating stress properties that needed to be tailored to handle the lightweight structure of the substrates to support the revolutionary imaging targets of both telescopes with respect to resolution and field of view as well as the high temporal resolution.