

Development and fabrication of a EUV, ultra-low blaze angle diffraction grating for a NASA space telescope

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The NASA Extreme Ultraviolet Explorer (EUVE) launched in 1992 was the first and last dedicated space telescope to operate in the Extreme Ultraviolet (EUV) band. The difficulty of accessing this wavelength region is due to the low number of photons that can escape the interstellar medium and reach Earth. To go beyond the scientific goals achieved by EUVE, any new EUV telescope needs to increase its effective collecting area.

In terms of EUV spectroscopy, this translates into the need for diffraction gratings with very high efficiency. The NASA CubeSat MANTIS (Monitoring Activity of Nearby stars with ultraviolet Imaging and Spectroscopy) due to launch in late 2026 will feature a one-of-a-kind EUV diffraction grating (Figure 1), offering the first orbital astrophysics EUV capability in over two decades. The grating design relies on a Variable Line Space (VLS) pattern (~ 1 to 8 microns period, or ~ 125 to 1000 grooves/mm over its 96 mm length) with an ultra-low blaze angle of 1.0 degree, covering a total area of 96x23 mm.

Ultra-low blaze angle gratings have been historically difficult to manufacture; we present the details of our nanofabrication-based processes that rely on electron-beam lithography of narrow features for patterning, and potassium hydroxide etching on precisely cut silicon wafers to form the atomically smooth blazed facets. We will summarize the particularities associated with $\langle 111 \rangle$ off-axis Si wafers etching and will list the optimizations required to get the best device performance. Preliminary efficiency results will also be presented, demonstrating how nanofabrication can play a significant role in the fabrication of diffraction gratings in high-energy astronomy, with potential applications in the synchrotron community.



Figure 1: Full-size prototype of the MANTIS grating: a 96x23 mm VLS diffraction grating, with a 20 nm zirconium coating.

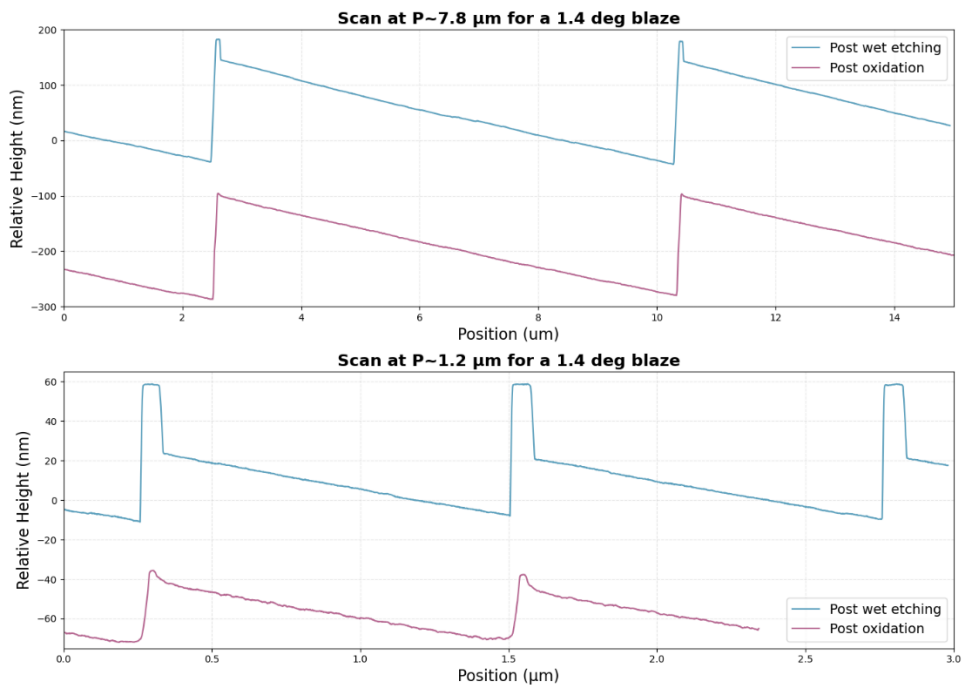


Figure 2: AFM traces of the low (top) and high (bottom) groove density side of a prototype grating: blue curves show the profile measured after KOH etching, while the red curves show the profile after a subsequent series of oxidation/etching designed to remove the Si nub, leftover from the wet etching process. This keeps the blazed facets mostly unchanged, with a very slight increase in microroughness to about $R_q \sim 0.3-0.5$ nm, before coating.