National Aeronautics and Space Administration

UV Spectroscopy Brassboard

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Program: FY21 R&TD Strategic Initiative   **Strategic Focus Area: UV Spectroscopy**

Objectives

The objective was to advance the performance of ultraviolet spectrometers at shorter wavelengths with higher performance. There were three main efforts. First, was to improve ultraviolet-grating fabrication. Todd Jones and John Hennessy developed a process for anisoptrically etching silicon to produce echelle gratings, a first at JPL. These gratings need to have straight grooves and flat substrates. Dan Wilson developed a process for writting very fine blazed gratings (333 nm periods with 175 nm depths) using grayscale e-beam lithography. These are several times finer than previously produced at JPL. These gratings can on curved substrates and the grooves can be curved. Second was to buy equiqpment for a facility to measure efficiency of gratings and ultraviolet spectrometers. Third was to buy samples-

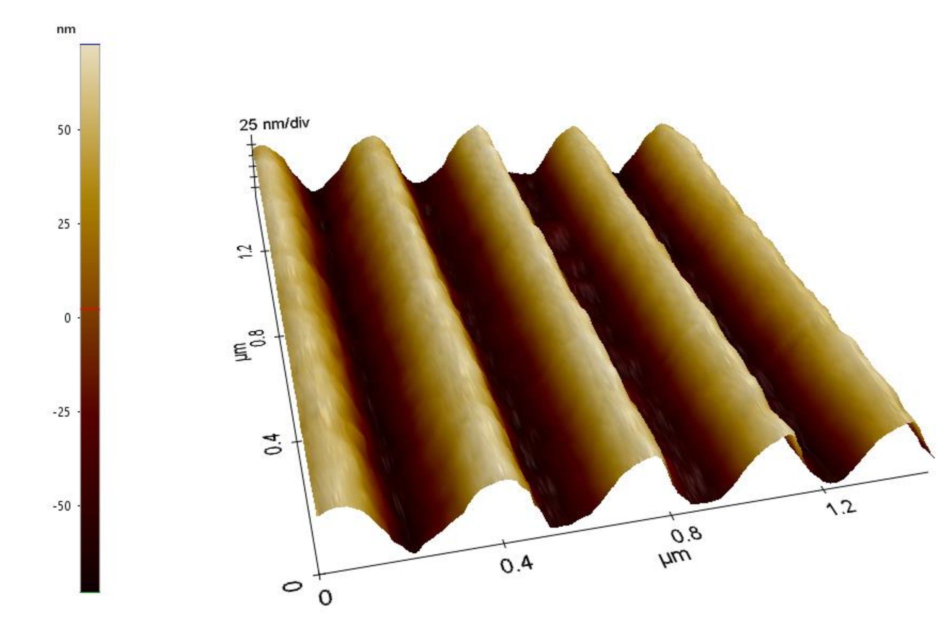
of refractive materials for vacuum ultraviolet instruments (LiF, CaF2, and MgF2) for radiation testing.

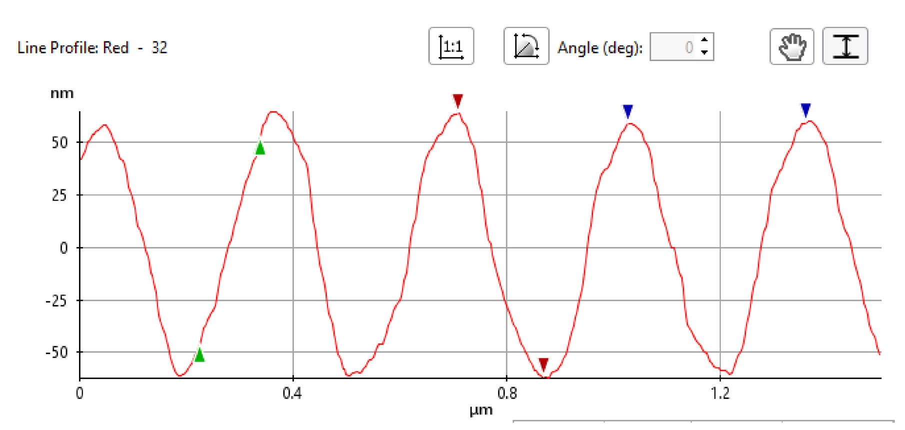
Background

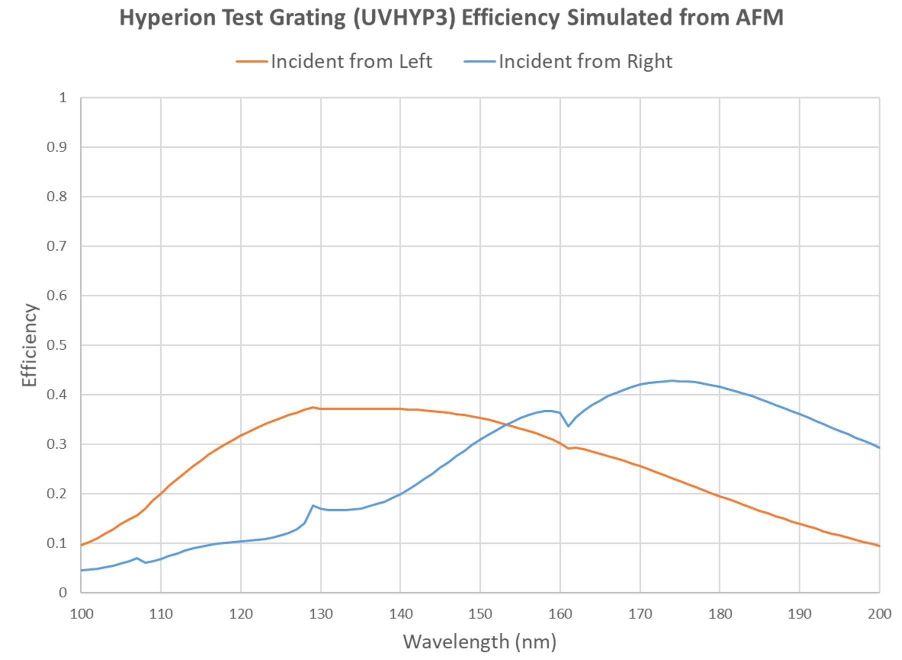
Vacuum ultraviolet spectroscopy opens a observational window for astronomy that is unobtainable from the ground due

to atmospheric absorption.

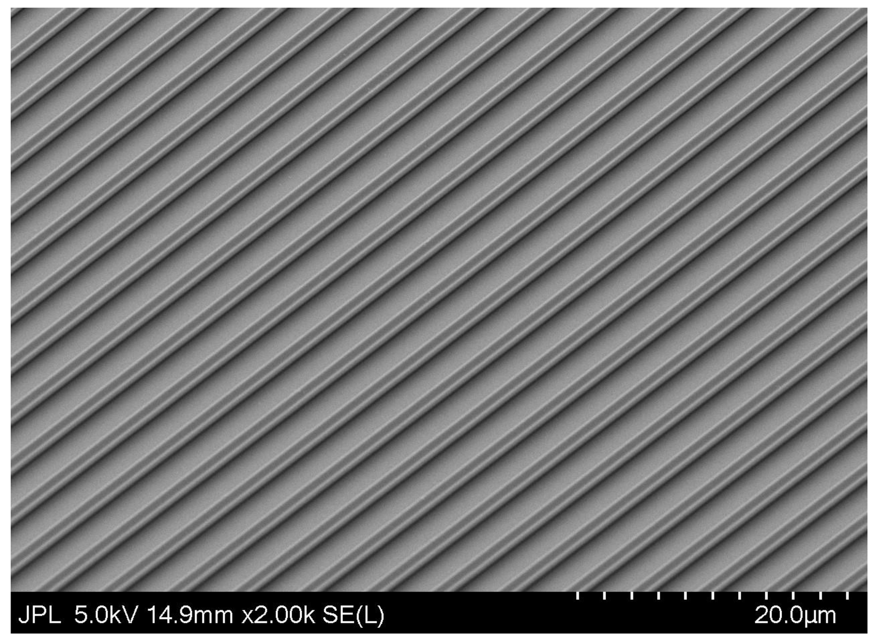
Approach and Results

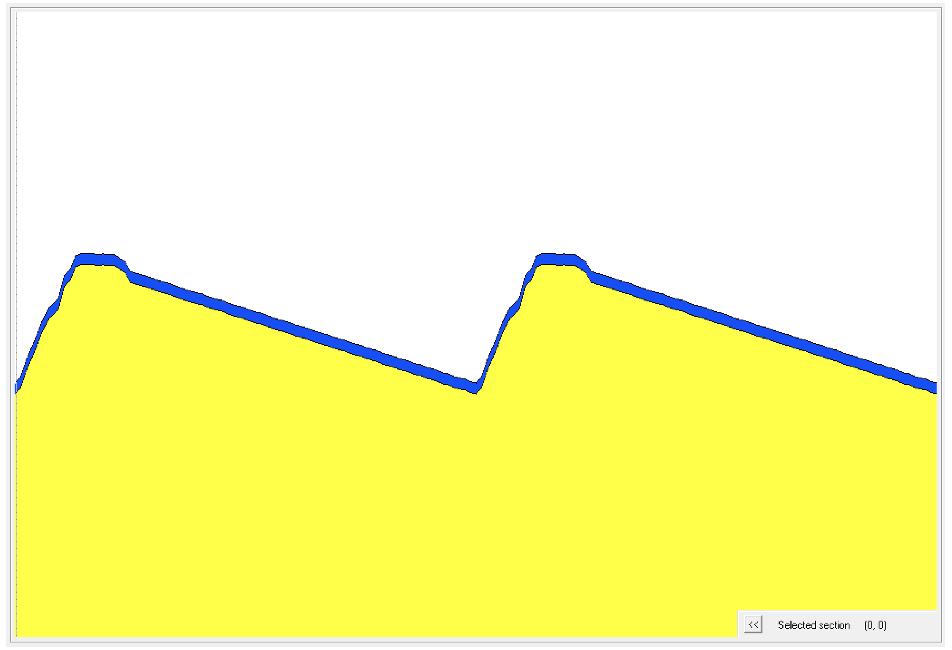


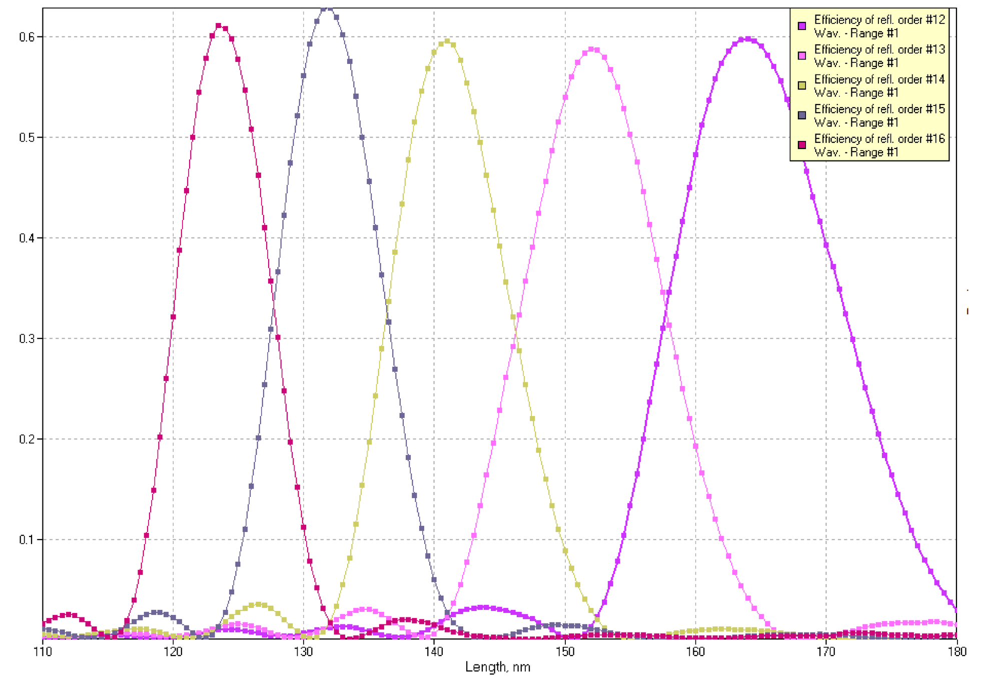




Fine grating made with an e-beam and grayscale resist
Profile is more sinusoidal than triangular, First try with PMMA (higher resolution than PMGI) may be able to do better by accentuating peaks and valleys of dose profile. Coating was assumed to be bare aluminum. Peak efficiency is 75% of theoretical







Echelle grating made by anisotropically etching Si

After a few process iterations anisotropic etching of silicon produced very flat grating facets. Performance is 75% of theoretical; sharper tips would improve performance.

Significance/Benefits to JPL and NASA

Better gratings will result in spectrometers that are smaller, lighter, higher resolution, lower scattering, and/or cheaper.

Knowledge of the radiation resistance and fluorescence of selected refractive materials in the vacuum ultraviolet down to 120 nm will increase the credibility of proposing prism spectrometers for next generation spectrometers.

Having the tools to characterize the gratings, prisms, and spectrometers down to 120 nm will allow JPL to build higher performing spectrometer. For gratings, being able to measure the performance at 120 nm is key to refining the manufacturing process. For prisms, the measurement is necessary to select mirror for the prism (radiation resistance varies from vendor to vendor and from boule to boule from the same vendor). Finally, the spectrometers must be tested

at the ultraviolet wavelengths to show the systems meet requirements.

Publications

None this year

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