Virtual Research Presentation Conference

Engineered optical coatings for far ultraviolet spectroscopy

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Program: Strategic Initiative (7X UV Spectroscopy)

Assigned Presentation # RPC-221

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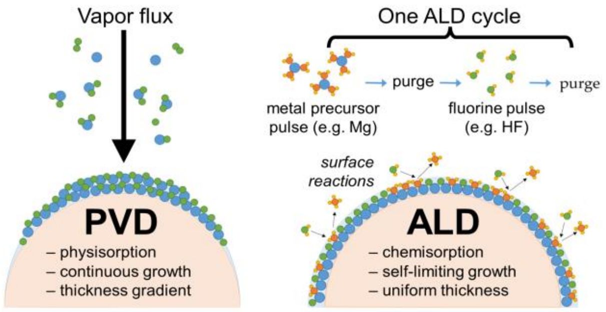
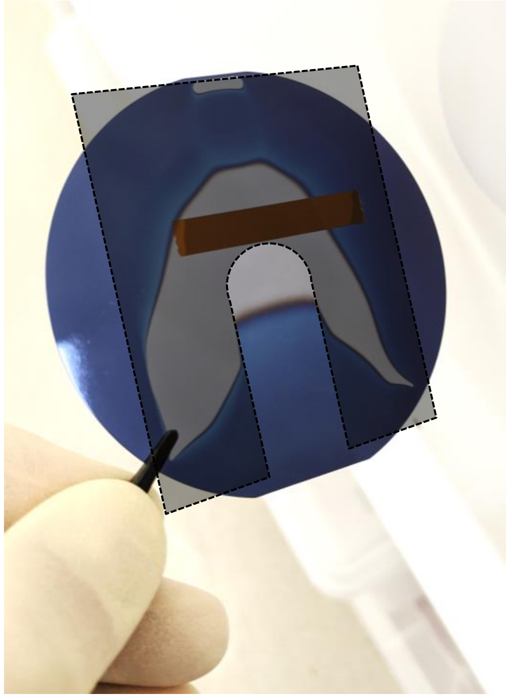
Tutorial Introduction

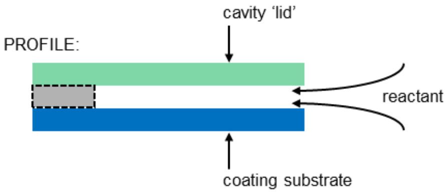
Abstract

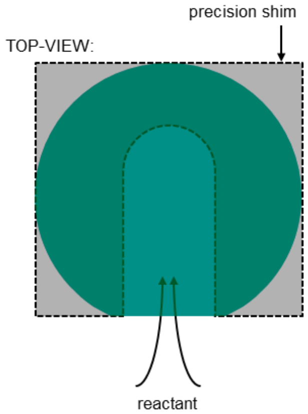
Our objectives include the demonstration of graded AR coatings and graded visible rejection filters in order to tune the spatial response of a detector system or stand-alone filter to the spectral dispersion of a given instrument. These coatings will be developed using atomic layer deposition in order to ensure compatibility with existing detector development activities at JPL's Microdevices Laboratory (MDL). We will also study the fabrication of fluoride protected Al mirror coatings with improved environmental stability and compatibility with polymeric diffraction gratings (e.g. greyscale ebeam process at JPL/MDL). Combined these elements are synergistic with other technological activities at JPL related to UV spectroscopy.



Graded Thickness Coatings by ALD





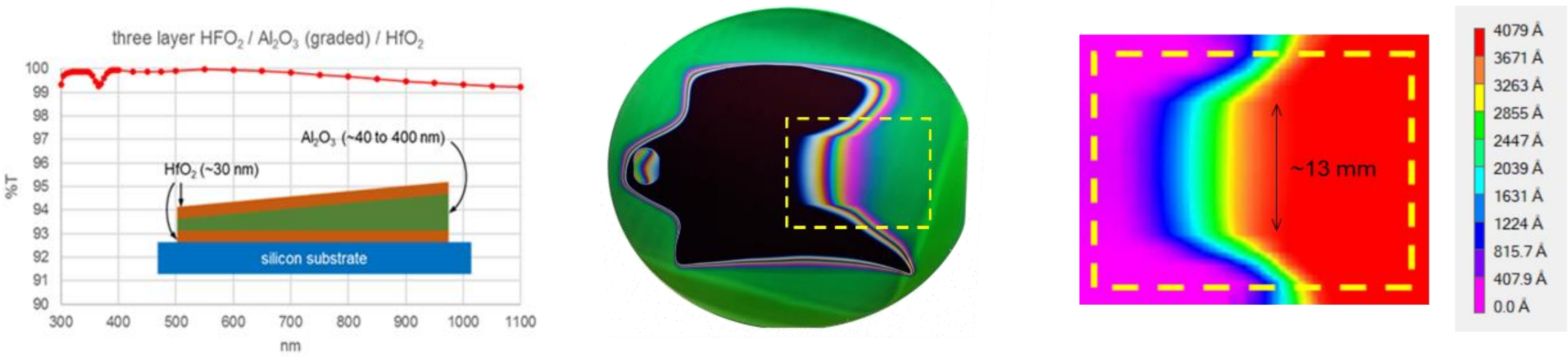


a) Force ALD into non-uniform mode by depositing into a cavity, ‘bottom-up’ approach

b) Conventional PVD graded thickness coatings deposited by masking or moving mechanical shutter

c) Ultimately want to extend to the FUV with metal-dielectric bandpass filters and integrate directly onto 2D-doped detector

Graded Thickness Coatings by ALD

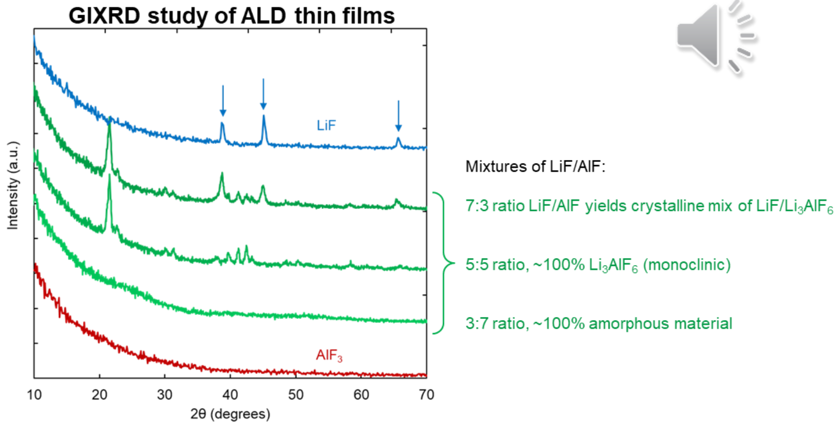


a) The modeled composite transmittance of a three layer anti-reflection coating on silicon.

b) A 75 mm silicon wafer coated with this structure composed of two uniform HfO_2 layers surrounding an Al_2O_3 layer of graded thickness.

c) The measured reflectance map of the outlined region on the wafer plotting the best-fit Al_2O_3 film thickness.

Engineering Stability in Metal Fluoride Coatings



ALD thin films on silicon	Starting thickness	ΔR (190–500 nm)
MgF_2	38 nm	0.5 %
LiF	54 nm	2.5 %
$LiAl_xF_y$ (Li-rich, 7:3 supercycle ratio)	80 nm	0.9 %
$LiAl_xF_y$ (5:5 supercycle ratio)	66 nm	3.8 %
$LiAl_xF_y$ (Al-rich, 3:7 supercycle ratio)	62 nm	7.8 %
MgF_2 / AlF_3 mixture	63 nm	1.6 %
AlF_3	40 nm	18.5 %
LaF_3 (high refractive index option)	24 nm	1.4 %
HfF_4 (high refractive index option)	67 nm	90.6 %

a) The ALD approach allows for arbitrary mixing of materials such as mixed compositions of LiF / AlF_3. We plan to use this approach to engineer improved environmental stability into UV fluoride optical coatings.

b) A subset of test coating evaluated for elevated temperature and humidity testing showing the change in measured UV reflectance before and after exposure. All coatings were deposited onto silicon wafers and exposed to 70% RH at 50 °C for 24 hrs.