National Aeronautics and Space Administration

FY24 Strategic University Research Partnership (SURP)

Multilayer Thin Film Coatings for Far Ultraviolet Spectropolarimetry

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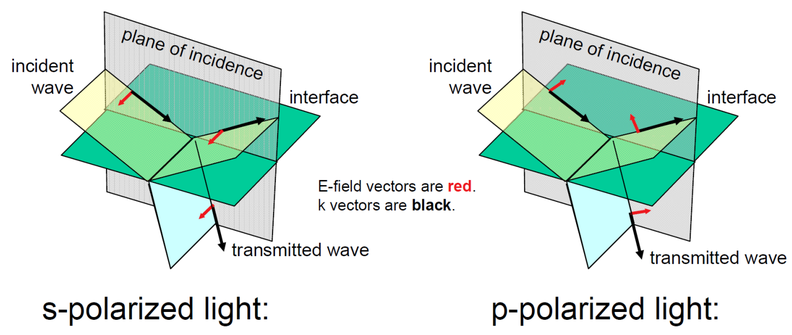
Objectives: The objective of this proposal is to develop multilayer coatings of oxides and fluorides for Far Ultraviolet (FUV) Spectropolarimetry. The proposed work will include (a) materials design, (b) thin film deposition and characterization, and (c) polarimetric spectroscopic studies in the FUV (90 – 200 nm).



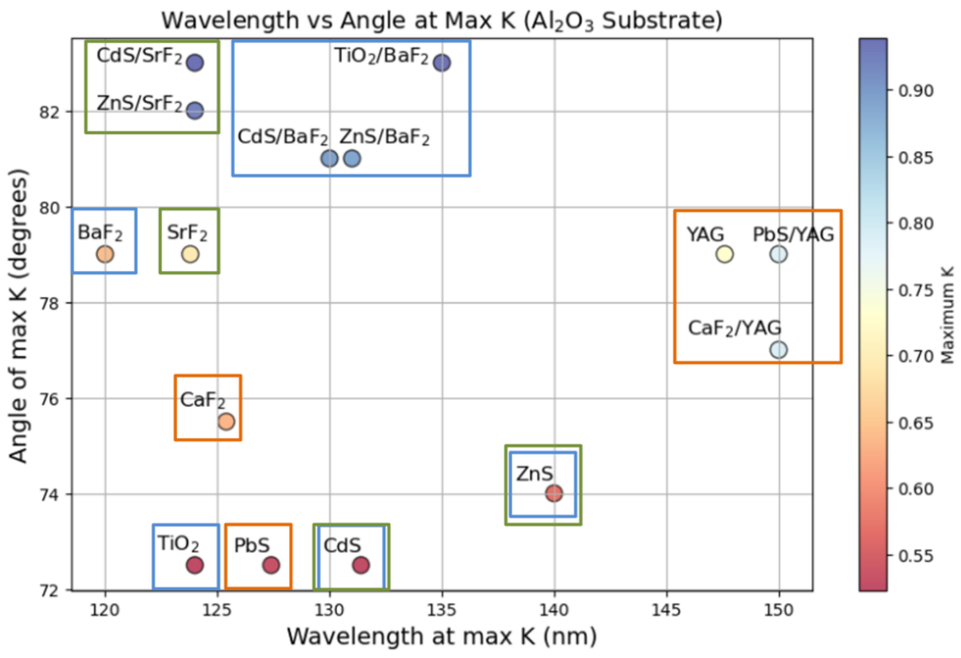
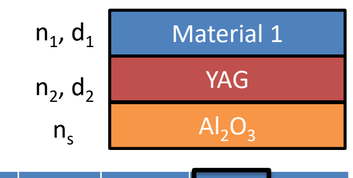


Figure 1. Summary of polarimetric figure of merit as a function of wavelength and the angle of incidence for single and bilayer geometry. The figure of merit is defined as: $\kappa = 2\,\mu^2 R$, where $R = (Rs+Rp)/2$ and $\mu = (Rs - Rp)/(Rs+Rp)$.

Example 1: Material 1/YAG/Al_2O_3 (sapphire substrate)

Material 1: SiO_2, SiO, TiO_2, $BaTiO_3$, PbS, FeS_2, CdS, $CuGaS_2$, CaF_2



Material 1	SiO_2	SiO	TiO_2	$BaTiO_3$	PbS	ZnS	FeS_2	CdS	$CuGaS_2$	CaF_2	$SrTiO_3$
Max. Quality Factor	0.7734	0.7390	0.7725	0.7195	0.7836	0.7496	0.7582	0.7656	0.7613	0.7864	0.7192
Thickness of material 1 (nm)	34	32	30	1	38	26	35	31	30	37	1
Thickness of YAG (nm)	11	17	20	11	18	20	17	19	19	11	11
Angle (degrees)	77	78	79	79	79	79	79	79	79	77	79
Wavelength (nm)	150	150	150	148	150	150	150	150	150	150	148

Single layer YAG on sapphire (Al_2O_3) substrate:

Material	Maximum K	Thickness at max K(nm)	Angle of max K (degrees)	Wavelength at max K (nm)	Rs at max K	Rp at max K	Material n	Material k	Substrate n	Substrate k
YAG	0.7309	11	79	147.60	0.7802	0.0169	2.5780	0.6273	2.1799	0.0625

Figure 2. Trade space exploration of various material combinations to form a reflective bilayer stack on sapphire with a starting layer of yttrium aluminum garnet versus a single layer example.

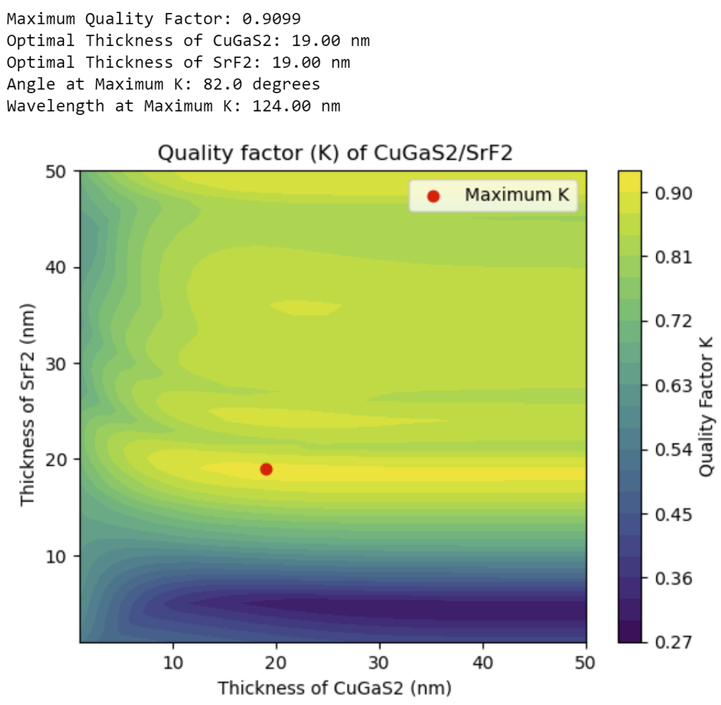


Figure 3. Layer thickness optimization for a specific bilayer combination of $CuGaS_2$ / SrF_2 to maximize the FoM.

Significance/Benefits to JPL and NASA: This is a natural enhancement to ongoing JPL efforts in UV spectroscopy and is supported by extensive experience in UV materials and characterization work at JPL. The long-term benefits of this program could lead to new FUV instrumentation that leverages existing JPL UV technologies in detector systems, optical coatings, and diffraction gratings.

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