Thin Film Filters and Coatings for Ultraviolet Astronomy, Astrophysics, and Planetary Science

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Significant advances in instrument technologies are enabling exciting new science in astrophysics, planetary science, and heliophysics. I will discuss JPL's 2D-doped silicon detectors and advanced coatings technologies, including a discussion of practical materials, design, and deposition techniques for ultraviolet (UV) films. JPL's 2D-doping process places the dopant within a few nanometers of the back surface, effectively eliminating the dead layer and extending device responsivity well into the UV. The result is 100% internal QE (i.e., reflection-limited response) from soft X-ray to the near infrared. As with most silicon-based detectors, the external QE (device response) can be further improved with AR coatings to mitigate reflection losses.

Ideal AR coatings are uniform, pinhole free, and reproducible. At JPL, we use atomic layer deposition (ALD) in preparing our AR coatings. ALD is a technique whereby films are grown through a series of self-limiting chemical reactions at a substrate surface. Due to its highly controlled growth mechanism, in which a film is deposited a fraction of a monolayer at a time, ALD offers nanometer-scale control over film thickness and composition with well-defined, sharp interfaces. These characteristics make ALD ideally suited for precision processing of scientific imagers—and optical components—where even slight non-uniformities in detector sensitivity can diminish science return. The effectiveness of ALD-based AR coatings for improving silicon photodetector response is now well-established.

When paired with our advanced coatings, 2D-doped detectors exhibit record UV performance. Advancements in sensitivity and throughput enabled smaller spacecraft—including sounding rockets, suborbital balloons, and CubeSats—to perform sensitive science measurements previously only possible with larger satellite platforms. JPL's 2D-doping and coatings technologies can be applied to virtually any silicon-based detector architecture, providing maximum flexibility in selecting the appropriate detector for the given science objective, meaning future Explorer, Probe, and Flagship missions will be more powerful than ever.