Antireflective Coatings Optimized for Vertical Bifacial Solar Arrays
Technical Assistance Request
Team AntiVertiGlare

To successfully produce an antireflective coating that is optimized for vertical bifacial solar arrays, assistance will primarily be required in the form of testing equipment. The bulk of the sol-gel synthesis itself and the construction of mini-modules to apply the coating to will most likely be able to be performed in-house without additional resources from outside sources. However, our team is currently lacking sophisticated equipment to test the properties of the coating and ensure that it is both capable of performing well at glancing angles and durable enough to be able to survive typical outdoor conditions and cleanings.

Deciding on the optimum refractive index and thickness for the AR coating will be critical. It will drive the sol-gel chemistry development. Careful optical modeling for all incidence angles must be performed and integrated into the known typical sunlight intensities as a function of time/date throughout the year. A single layer AR coating may be sufficient, but bilayer or trilayer structures may be tested, too. Dedicated software for doing ray-tracking and Fresnel coefficient calculation could accelerate this design phase.

The first piece of physical equipment that would be useful for the testing of potential antireflective coatings is an ellipsometer, which can determine the refractive index of the coating and the amount of reflection from the coating surface as well as a bare glass surface at glancing angles in order to determine whether the antireflective coating is successfully lowering the reflected intensity. Having this instrument as opposed to needing to design and craft a similar mechanism ourselves would simplify the initial testing and allow the narrowing-down of potential coatings to occur much faster. This would in turn allow a completed product to be finalized in a shorter timeframe. In conjunction with an ellipsometer, a solar simulator or other light source that closely mimics the intensity and spectral properties of natural sunlight would be beneficial for conducting testing on the antireflective coating performance. The current solar simulator that our team has access to can only illuminate a very small area, which will likely not be enough for a full understanding of the antireflective coating's behavior. While some useful results on reflectance can be gleaned from any light source, the best proof of concept for an antireflective coating meant to be applied to solar panels is data from a light source that is similar to the sun. Knowing how the coating behaves under near-sunlight conditions from the start also reduces the likelihood of setbacks or unexpected variables later in the process when the coating is tested on an actual array.

Once a coating is shown to effectively reduce reflection and increase power production at glancing angles, it will be important to determine its mechanical properties and how it holds up to weather factors such as temperature and humidity. The International Electrotechnical Commission has put out standards for these types of testing, including an abrasion test, a damp-heat test, and a humidity-freeze test. While it is likely possible for our team to perform basic abrasion testing with our current resources, an area capable of reaching temperature extremes and having precise humidity control for the other tests is not currently available to us. Having this resource would allow for confirmation that the antireflective coating will survive the lifetime of the solar array in outdoor conditions.

A bit further down the line, assistance will be required in scaling-up the coating process in order for the performance of the antireflective coating to be evaluated in real-world conditions on an actual solar array. While proof that the coating functions well in a lab setting is enough for a research paper, in order to create a commercially viable product there must be confidence that it performs well under actual conditions. Our team does not currently have the resources to apply common application methods such as spin-coating to substrates of as large of a size as is required to cover a standard solar panel.