

# PHOTONICS spectra®

## WHITE PAPERS & APPLICATION NOTES

### Textured Antireflective Surfaces for High-Power Applications



#### OVERVIEW

In applications using high-power lasers, antireflective (AR) optics are important to ensure that stray beams are minimized. However, traditional dielectric thin-film AR coatings can also present problems, as their laser damage threshold is typically lower than that of the optics themselves, limiting the power of infrared (IR) or visible lasers. In addition, as the number of optical layers increases, the total reflectance from AR coatings can compound, leading to problematic power loss.

Thorlabs' textured AR surfaces present an alternative to thin-film coatings with significantly higher laser damage thresholds. They also provide lower reflectance over a broader range of wavelengths and angles of incidence than is possible with thin-film coatings. As a result, substrate-coated optics for textured optics in a high-power system can improve the performance and the robustness to damage during operation.

#### TECHNOLOGY

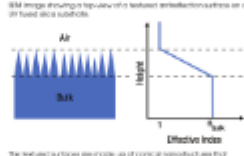
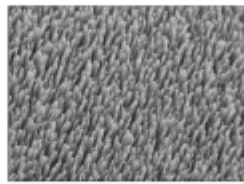
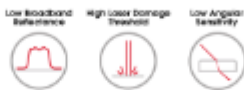
Thorlabs' textured AR surfaces are created by removing material from the bulk optic substrate using a proprietary process, which has been optimized to fabricate subwavelength structures. The surface that remains consists of regularly spaced nanostructures with regular spacing and varied height. These nanostructures produce a smooth gradient of the refractive index from the bulk substrate to the air, as shown schematically in the figure to the right. Since there are no sharp changes in the refractive index, the incident light is able to travel from the air to the bulk glass and vice versa with virtually no Fresnel reflections. As a result, textured optics can achieve significantly higher transmission than untextured optics and optics with traditional thin-film coatings.

#### EXAMPLE: TEXTURED WINDOWS

Thorlabs has developed a line of windows with textured antireflection surfaces using UV fused silica (UVFS or Infrasil®) as a substrate. UVFS windows with a T1 textured surface exhibit antireflection performance from 400 nm to 1100 nm, while optical windows with the T2 surface have antireflection performance from 1000 nm to 1300 nm. The table to the right shows the specifications for both surfaces. Our stock windows with these surfaces maintain ≥95% transmission across their spectral range.

Textured windows can also be created using different substrates and with surfaces designed for wavelength ranges from the UV to the IR.

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The textured surface is made up of conical nanostructures that produce a smooth refractive index gradient for the light traveling from air to the bulk substrate.

Surface Name	T1	T2
Substrate	UV Fused Silica	Infrasil
Wavelength Range	400 - 1100 nm	1000 - 1300 nm
Reflectance (Max. Broadband Range)	$R_{\text{max}} < 0.25\%$	
Surface Quality	10-A Scratch-Dig	
Damage Threshold	100 J/cm <sup>2</sup> at 1064 nm, 100 J/cm <sup>2</sup> at 1064 nm, 10 W, 10 Hz, 200 fs; 10 W, 10 Hz, 200 fs	100 J/cm <sup>2</sup> at 1064 nm, 100 J/cm <sup>2</sup> at 1064 nm, 10 W, 10 Hz, 200 fs

## Textured Antireflective Surfaces for High-Power Applications

Thorlabs' Textured AR Surfaces present a powerful alternative to traditional coatings. The treated surface provides significantly higher resistance to laser damage alongside lower reflectance across a broader wavelength range with minimal sensitivity to angle. This technique can be applied across a wide variety of optical elements, making it ideal for most high-power laser applications and applications requiring low sensitivity to the incident angle of the light.

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