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EVAPORATED COATINGS INC

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Anti-Reflection Coating – AR Coating

Anti-reflection coatings reduce first surface reflection losses, improve contrast and boost the transmission through your optical surface. Choose from a typical design below or ECI will design and deposit a custom anti-reflection (AR) coating for your specific application. If you are not sure how to specify your coating, our design team will work with you to identify the optimum design for your system.

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AR COATINGS FOR FIBERS AND FIBEROPTIC DEVICES

AR COATINGS FOR CRYSTALS AND SEMICONDUCTOR MATERIALS

IBS AR COATINGS

What are AR Coatings?

AR Coatings (Anti-Reflection coatings) are deposited onto optical surfaces to reduce specular reflectivity. Anti-Reflection coatings are comprised of a single layer or multiple layers. These designs are optimized to create destructive interference with respect to the reflected light. This design approach will allow the maximum amount of light transmission without compromising image quality. Diagram 1 is an example of a typical multilayer Anti-Reflection coating.

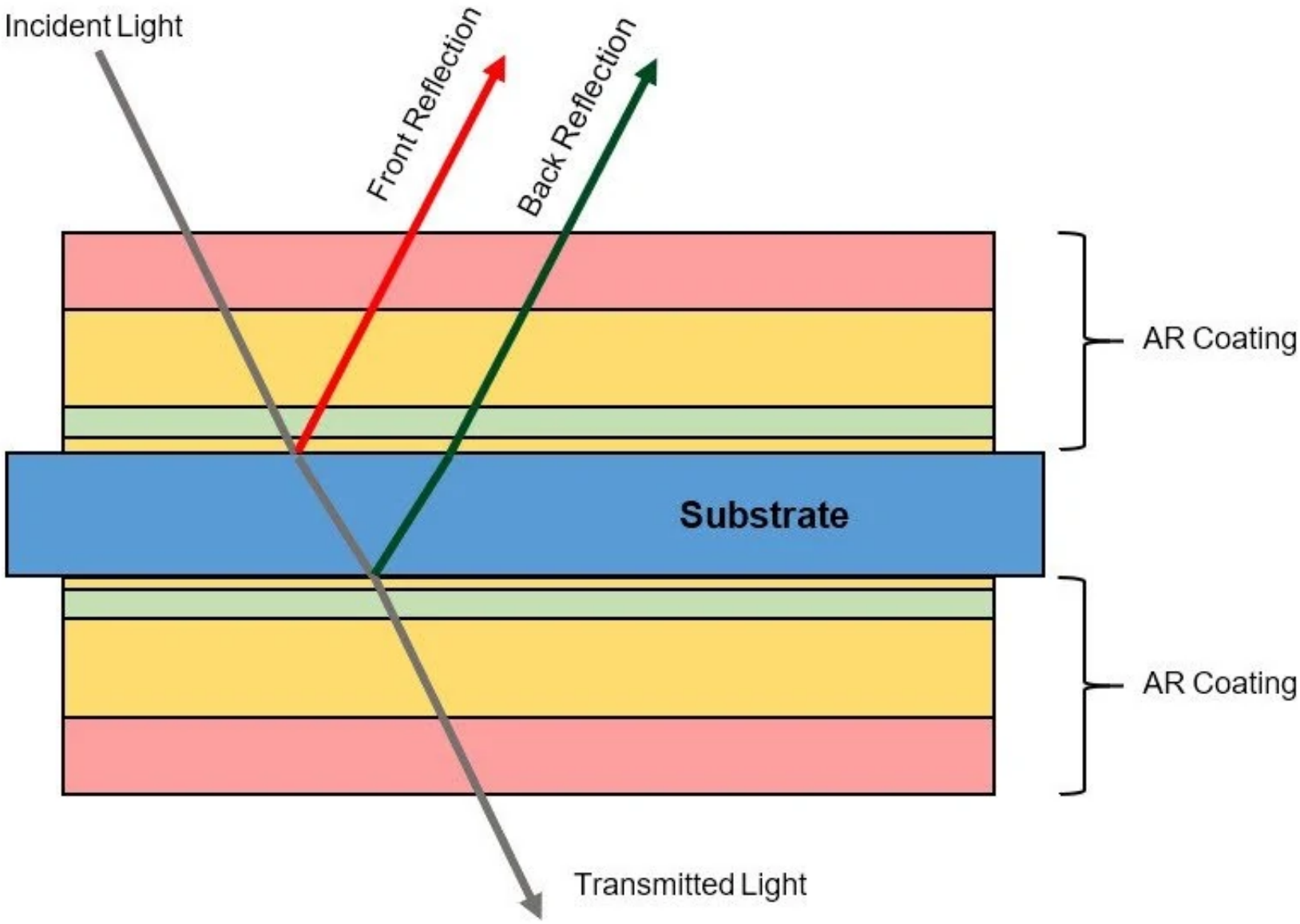


Diagram 1: Anti-Reflection Coating Model

Anti-Reflection Coating Applications

Anti-Reflection Coatings can be optimized for narrow and **broadband applications**. The performance of an AR coating will vary depending on the bandwidth and angle of incidence (AOI). ECI can typically achieve front surface reflection less than 0.03% for a narrowband AR coating at near normal incidence. Anti-Reflection coatings optimized for wider bandwidths will display a higher maximum reflection. A typical Broadband Anti-Reflection coating on glass will have a maximum reflection of less than 0.5% with a typical average reflection of 0.25%. Figure 1 shows how reflection performance can vary with bandwidth.

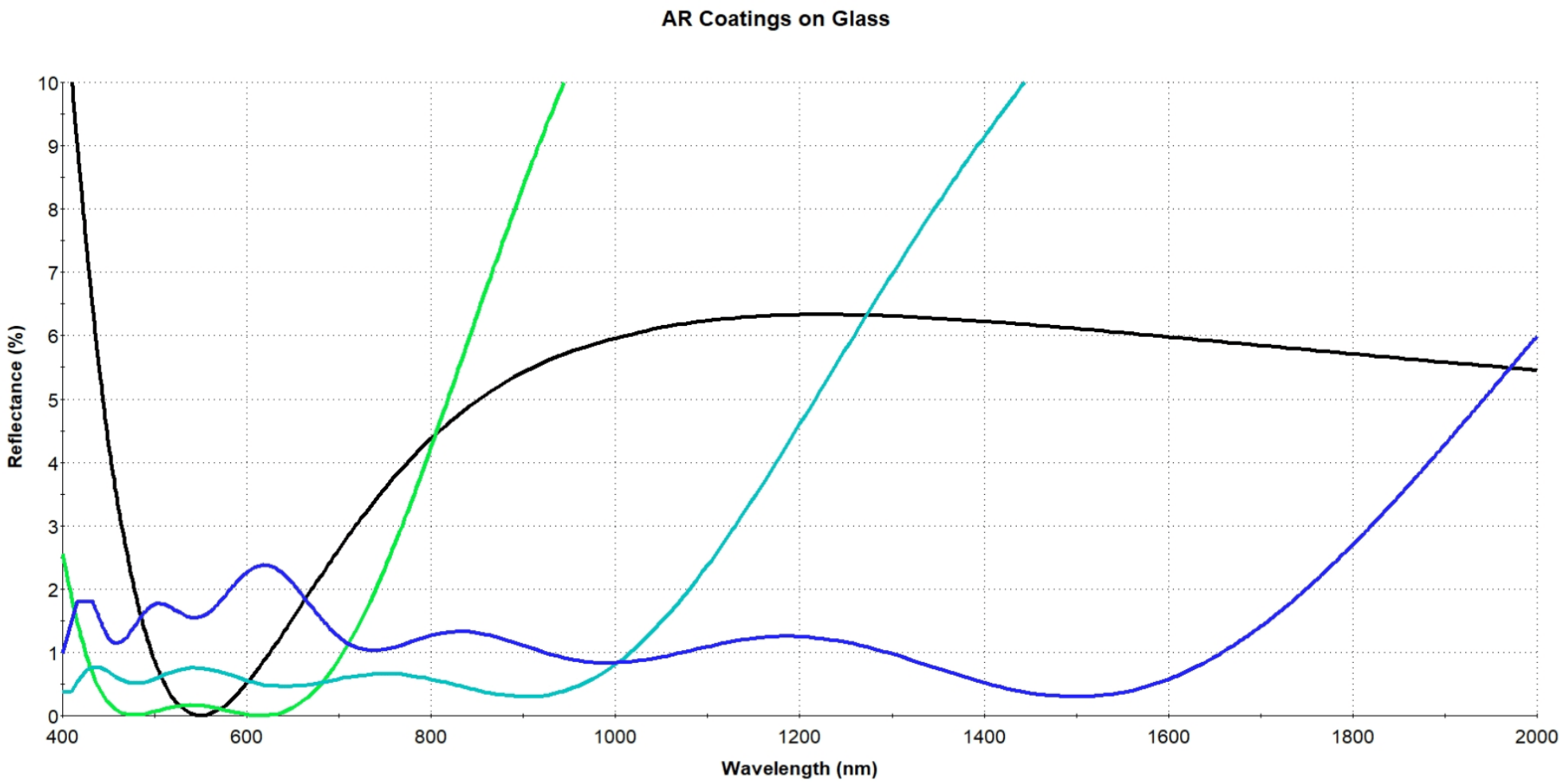


Figure 1: AR Coating Performance for Various Bandwidths

Evaporated Coatings Inc. offers anti-reflection coatings for a variety of **substrate materials** and configurations. Different coatings materials are selected depending on the substrate material, size, shape, and wavelength range of interest. In many cases, the choice of substrate material dictates the deposition temperature of the AR coating. For narrowband Anti-Reflection coatings, the optical performance is similar for both low and high temperature depositions. However, the performance of a broadband AR Coating will vary depending on the deposition temperature. Typically, broadband AR coatings deposited at higher temperatures will yield lower average reflection over a particular bandwidth. There are two primary reasons: 1). certain coating materials require deposition at elevated temperatures for sufficient durability and 2). the refractive indices of some materials decrease when deposited at lower temperatures.

For example, a visible broadband AR coating on BK7 will have slightly better optical performance than a visible broadband AR coating deposited on Polycarbonate. Figure 2 shows the difference in performance between the two substrates mentioned above.

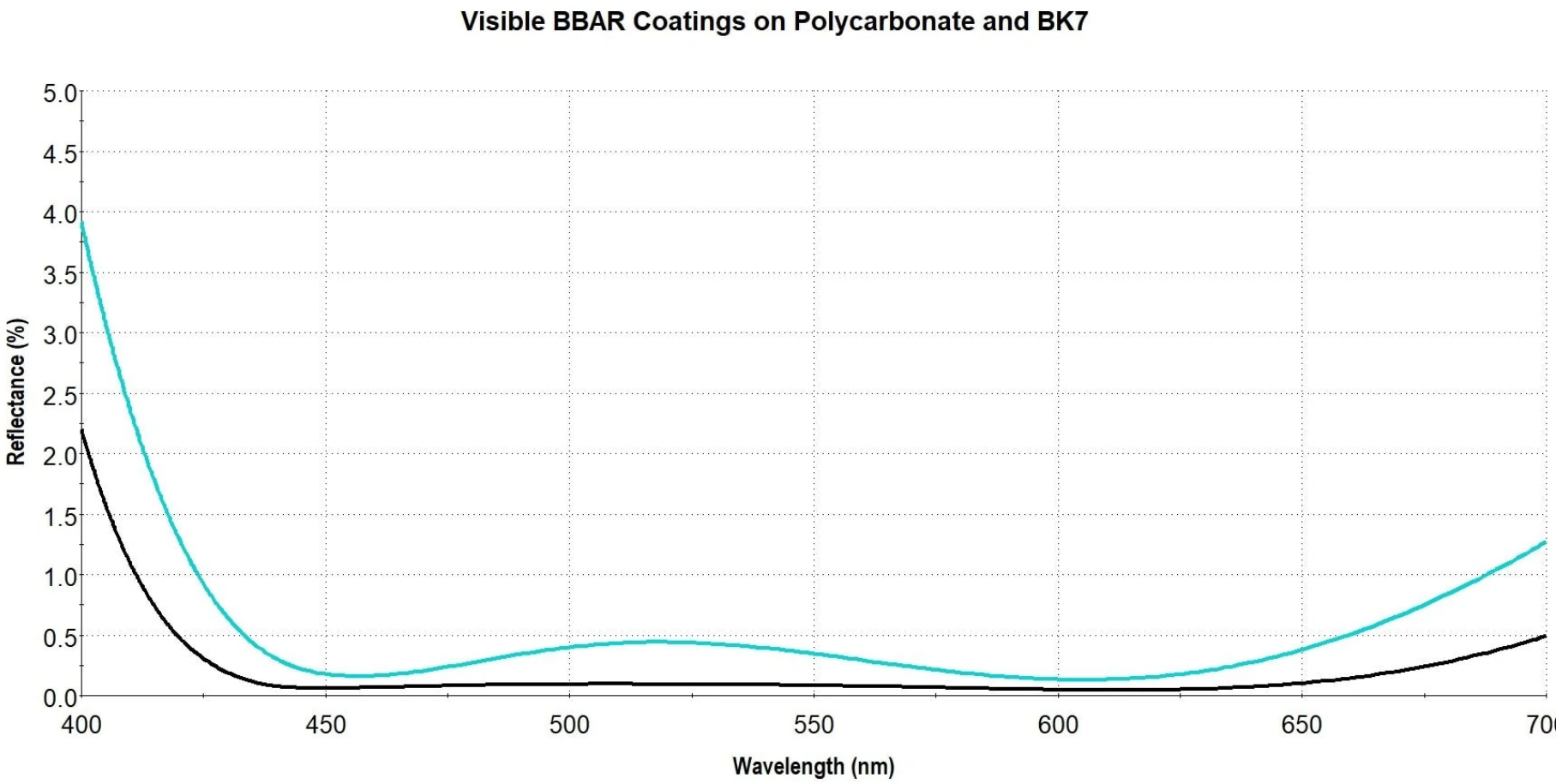


Figure 2: Visible BBAR Coatings on Polycarbonate and BK7

ECI has extensive experience coating polymers and other temperature sensitive substrates. ECI has been coating polymer optics for over 60 years. Our low temperature Anti-Reflection coatings are designed and deposited to ensure good adhesion and thermal stability on even the most challenging polymer substrates. ECI coats different types of substrate with low temperature Anti-Reflection coatings at process temperatures below 50°C. These substrates range from plastic windows and lenses to optical fibers and fiber optic assemblies/components including: Molded Polymer Optics, Polycarbonate, Acrylic, Zeonex®, Ultem®, Mylar®, CR39, COC, Fresnel Lenses, TO-Window Cans, MT Ferrules.

ECI also deposits high temperature Anti-Reflection coatings on various substrates, including crown glasses, float glasses, Fused Silica, Sapphire, Silicon, CaF2, and others. ECI can deposit these coatings to cover any wavelength range between 200 – 2500nm. These coatings are designed and deposited to meet the durability requirements per MIL-C-675C. ECI deposits Anti-Reflection coatings on parts up to 400mm in diameter.

Anti-Reflection coatings are utilized in a variety of applications. It is very common for AR coatings to be used in laser applications. In such cases, Anti-Reflective coatings will need to meet or exceed certain LDT (Laser Damage Threshold) requirements. ECI primarily uses **Ion Beam Sputtering** (IBS) or Electron Beam (E-Beam) to deposit AR coatings that must withstand high power lasers.

ECI deposits High Power Anti-Reflection coatings on several different types of substrates, including but not limited to **Glass**/Fused Silica windows, lenses and wafers, **Fiber optic cables** and assemblies, LBO, BBO, KTP, TGG, GGG, BiG, and Silicon wafers.

The tables below show recent results from Laser Damage Threshold tests of some of ECI's AR coatings at 1064nm.

Table 1: Laser Damage Threshold test results for pulsed lasers

Coating Type	Deposition Method	λ (nm)	AOI (°)	LDT (10ns pulse)
AR	IBS	1064	0	22.5 J/cm^2
AR	E-Beam	1064	0	63 J/cm^2

Table 2: Laser Damage Threshold test results for CW lasers

Coating Type	Deposition Method	λ (nm)	AOI (°)	LDT (CW)
AR	IBS	1064	0	2GW/cm^2
AR	E-Beam	980	0	> 1.5MW /cm^2*

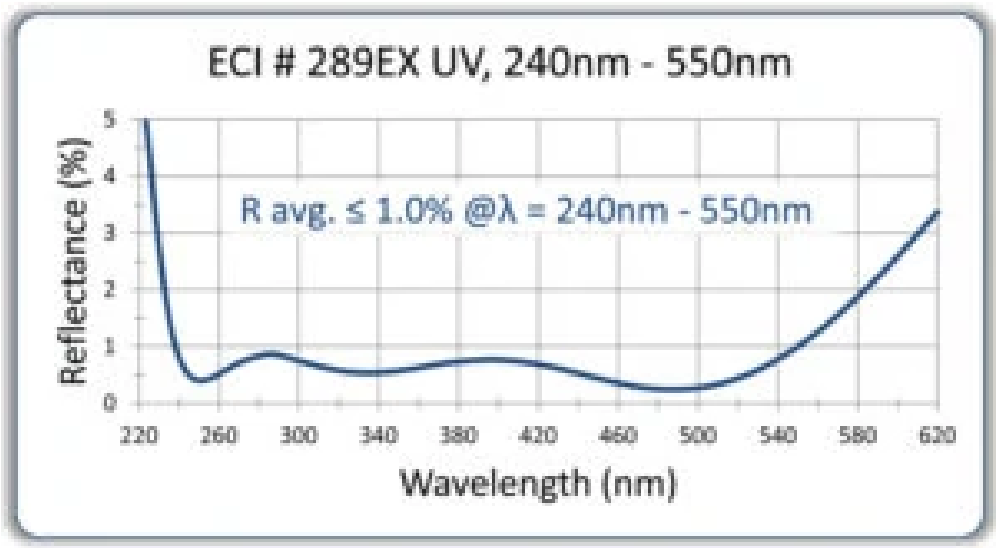
*Tested at maximum power with no damage.

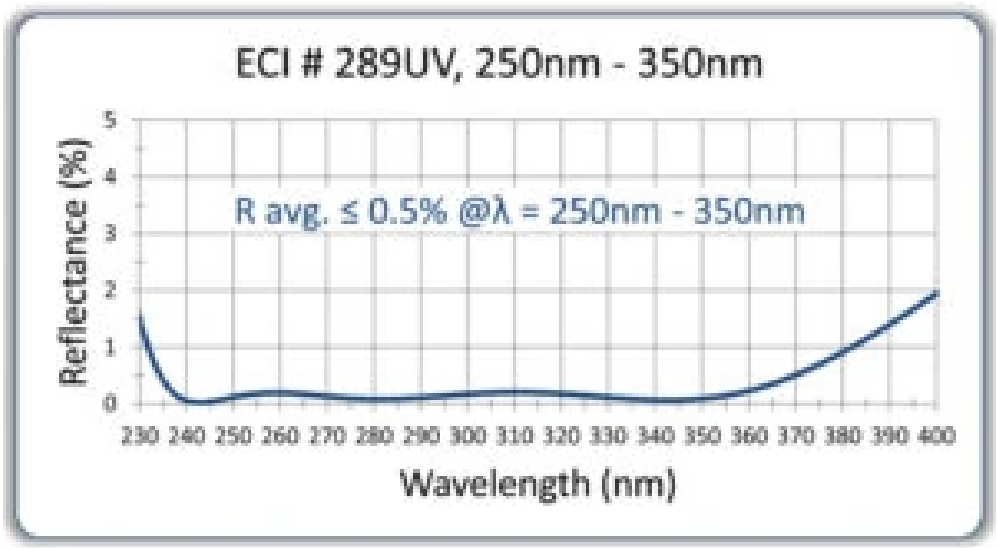
Typical values verified through independent test laboratories. Actual LDT performance is dependent on substrate selection, surface preparation, and system design.

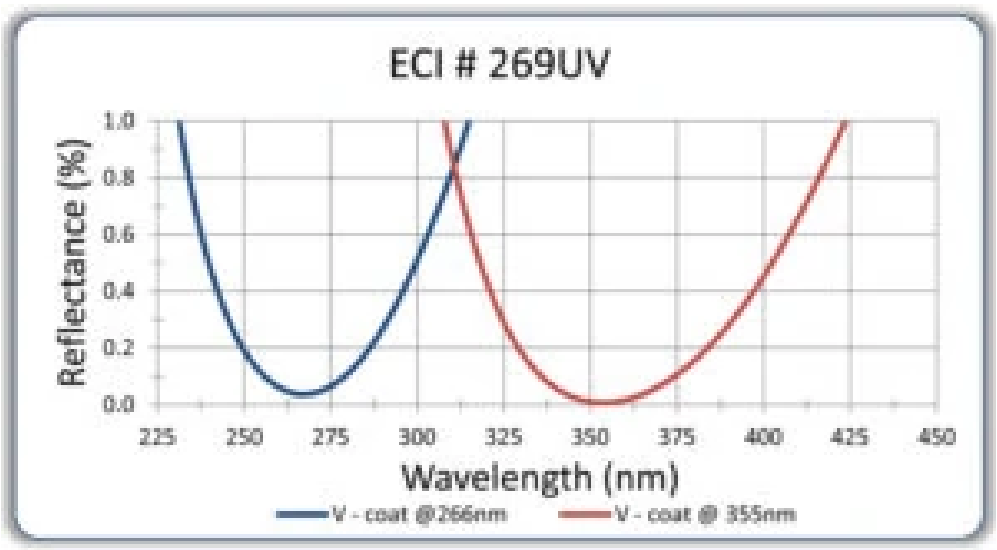
ECI's AR Coatings meet the reflection and environmental requirements of MIL-C-14806A and MIL-C-48497. Designs comply with military and telecommunication industry standards.

ECI's durable films on plastic and polymer molded optics are resistant to organic solvents and are an excellent choice for a wide variety of products.

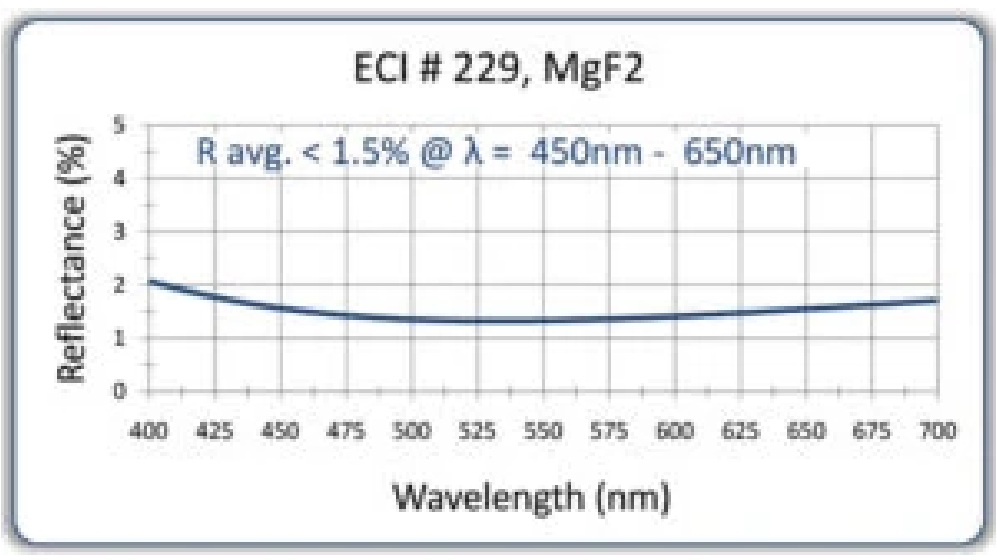
Typical UV AR Coating Designs for Glass Substrates:

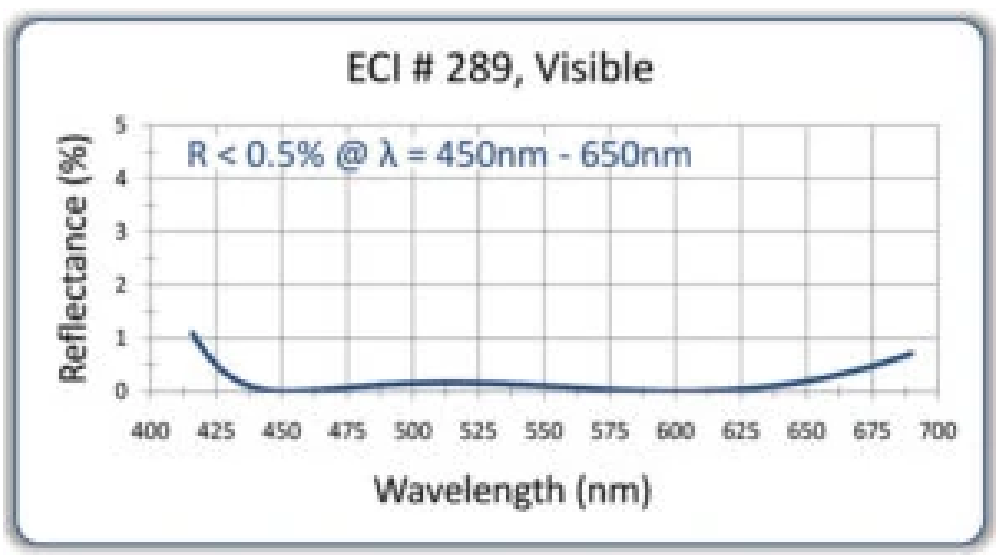


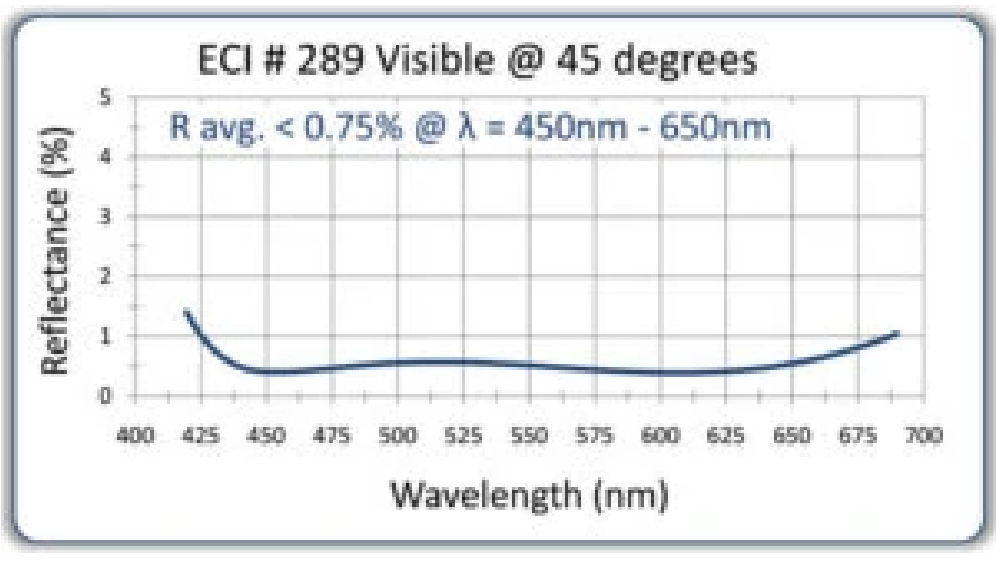




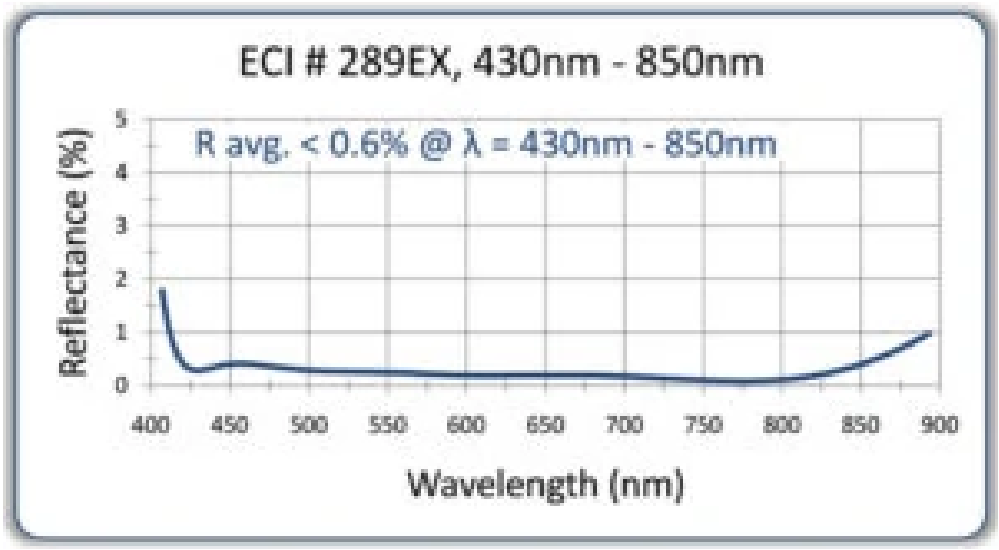
Typical Visible AR Coating Designs for Glass Substrates:

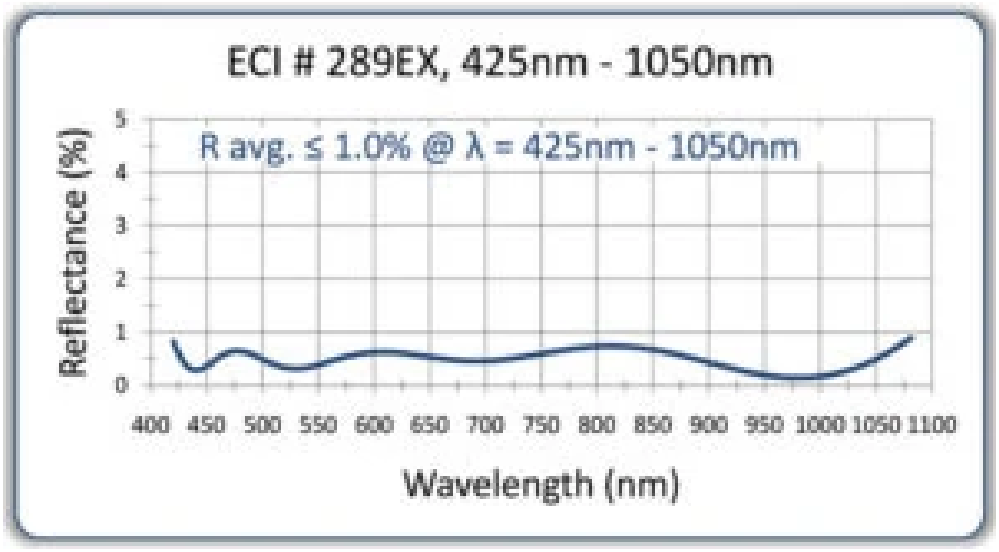


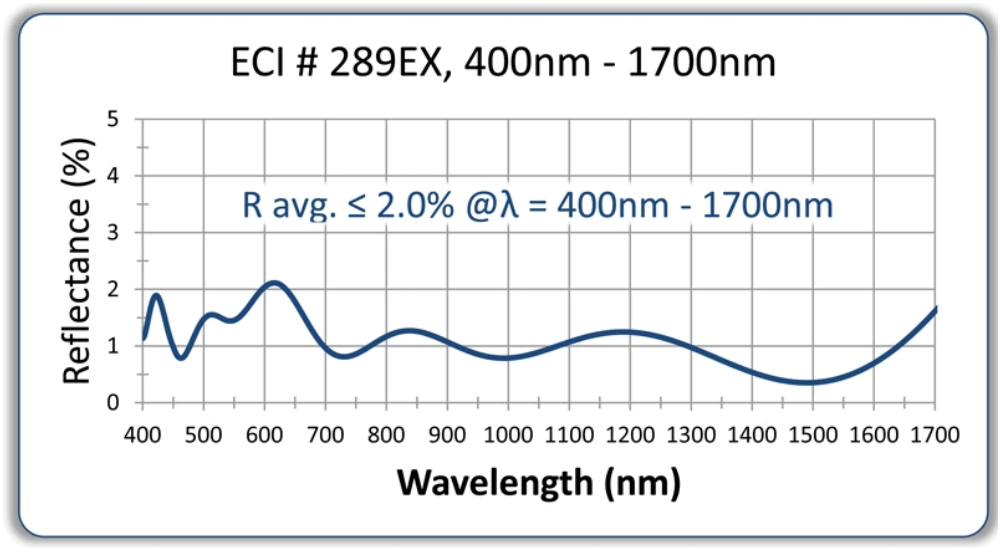


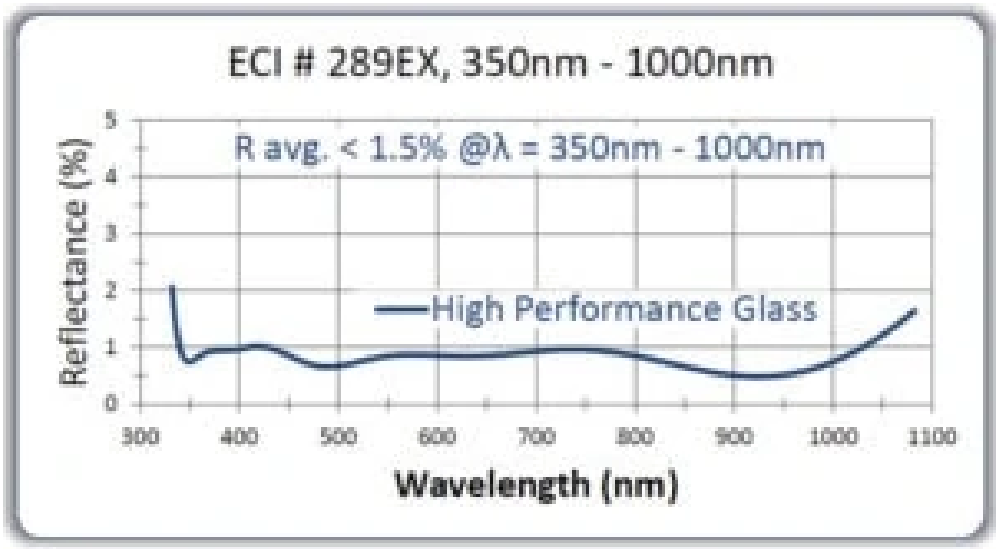


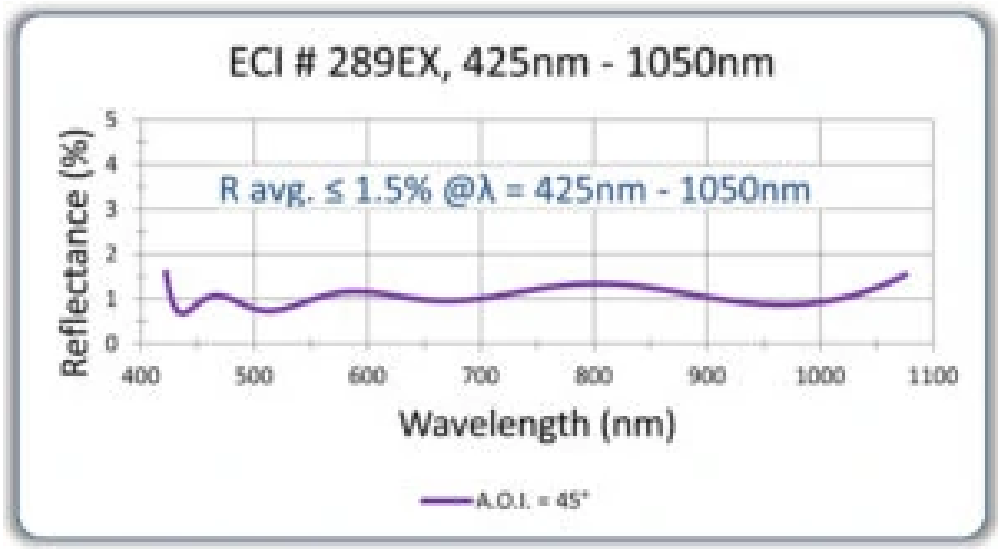
Typical Visible – NIR AR Coating Designs for Glass Substrates:



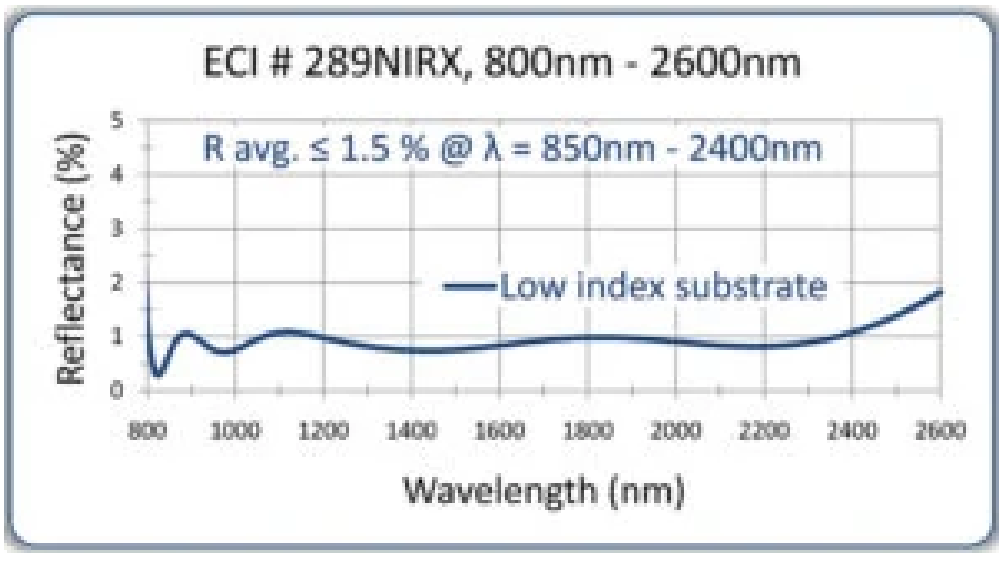


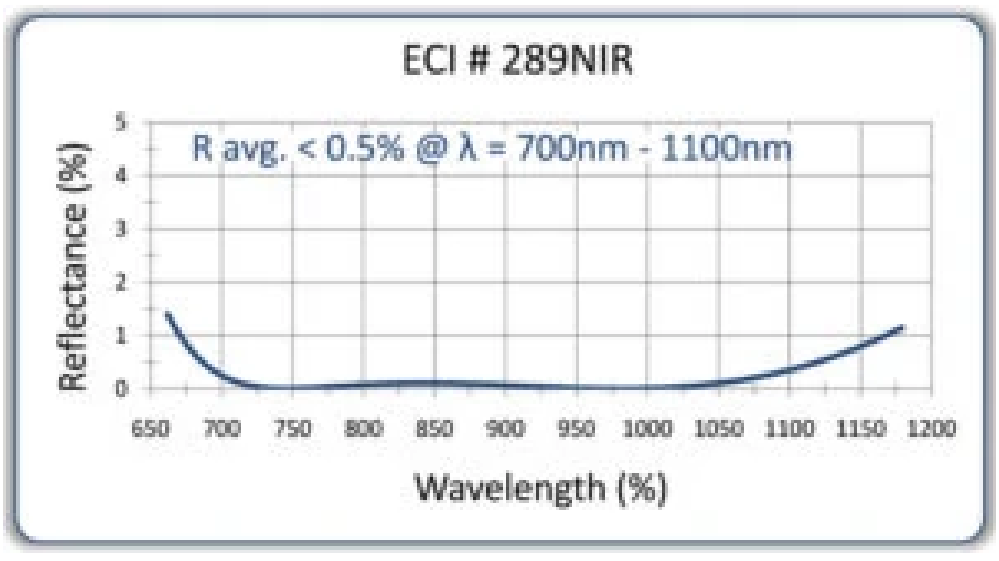


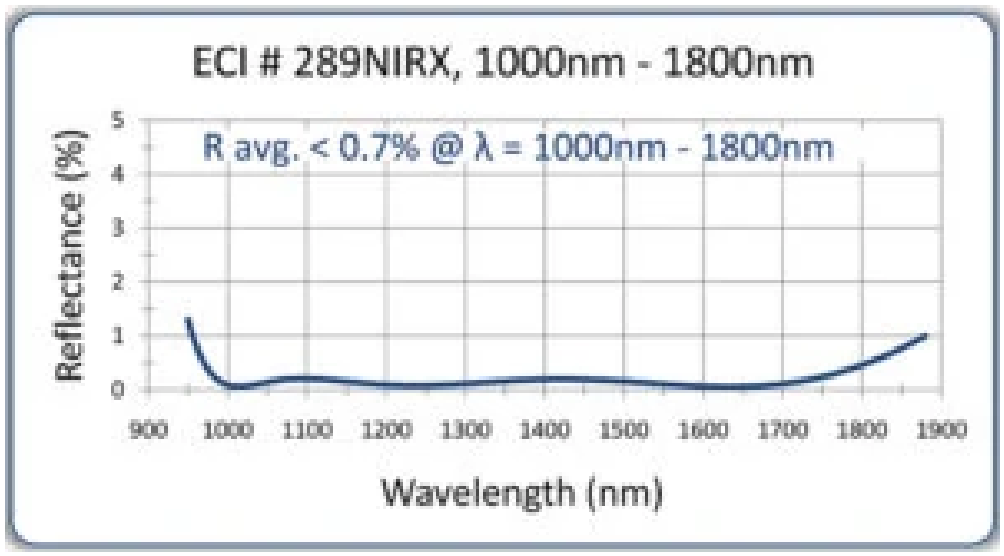


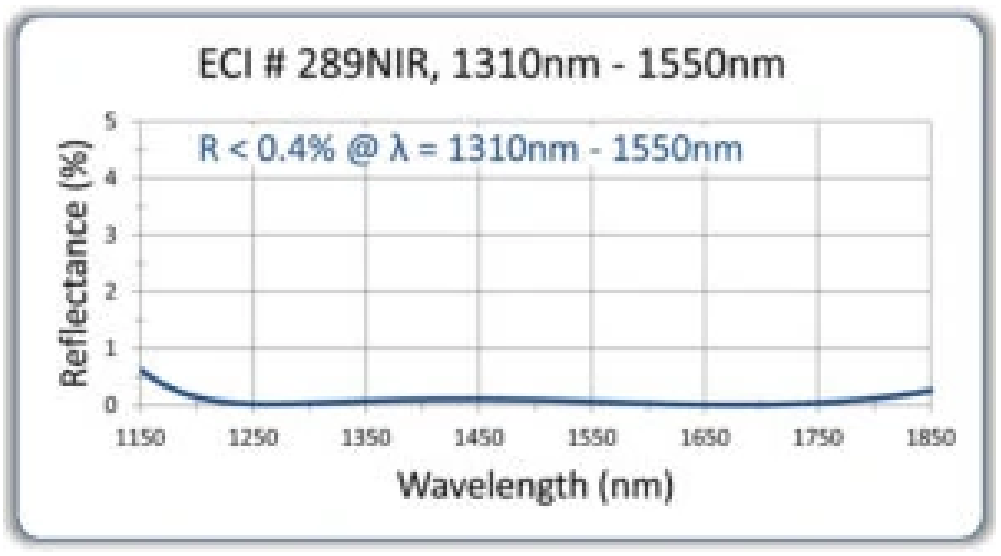


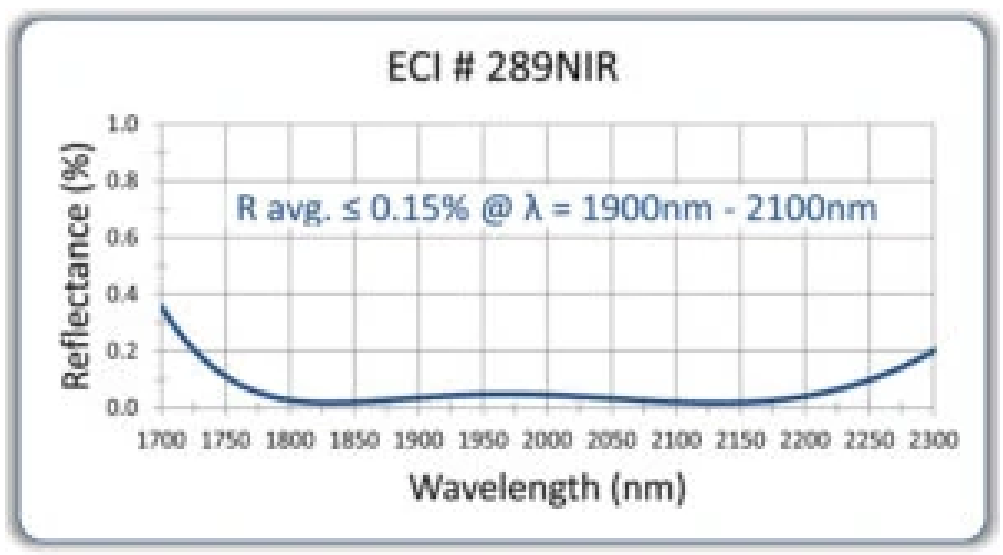
Typical NIR AR Coating Designs for Glass Substrates:



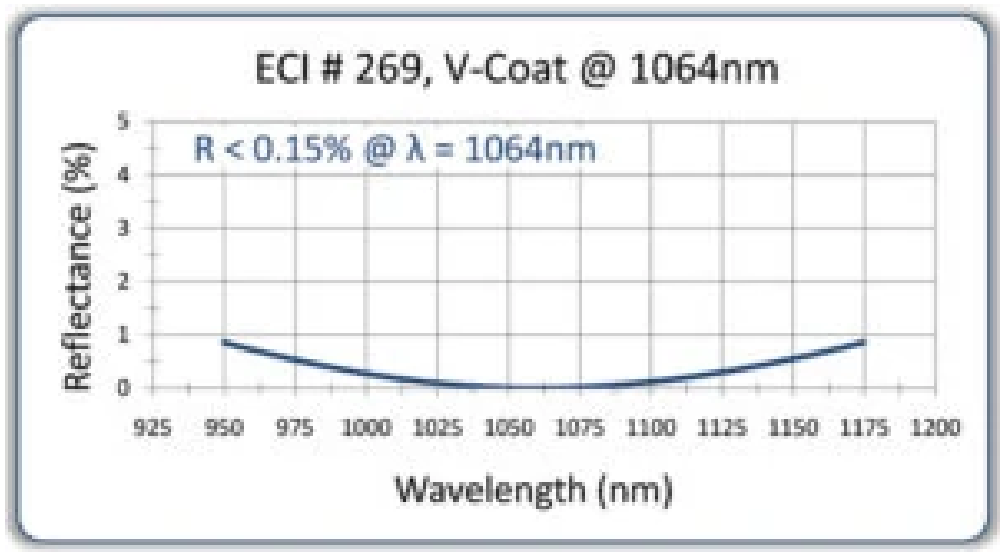


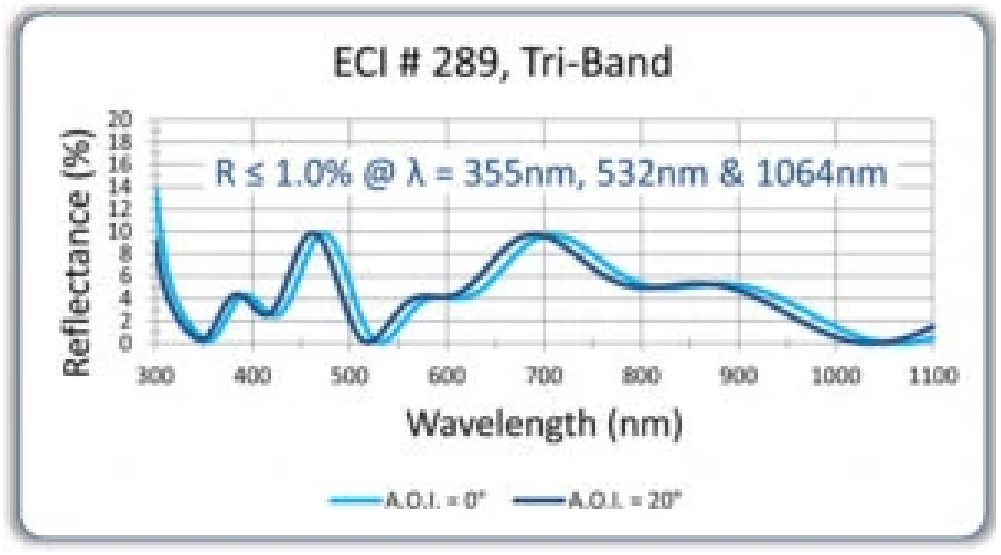


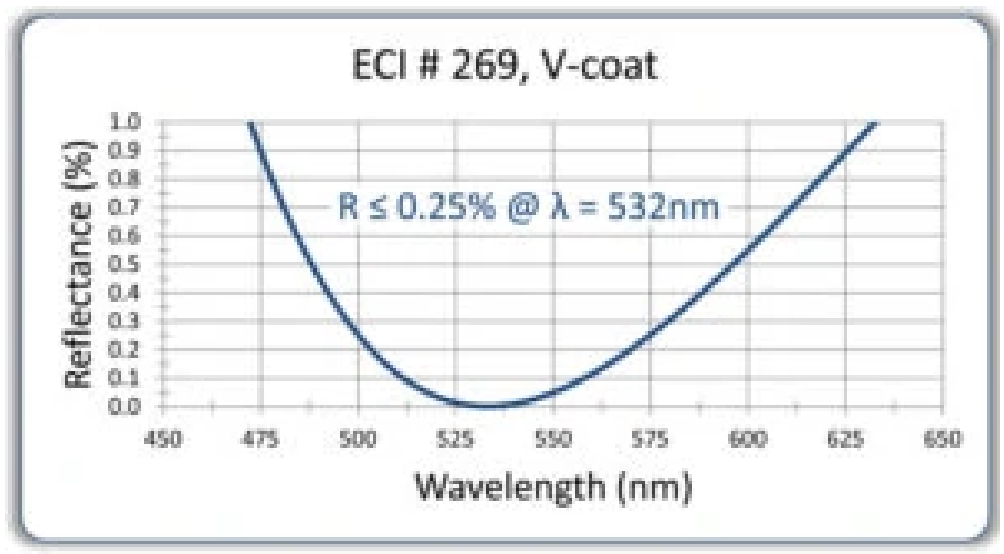




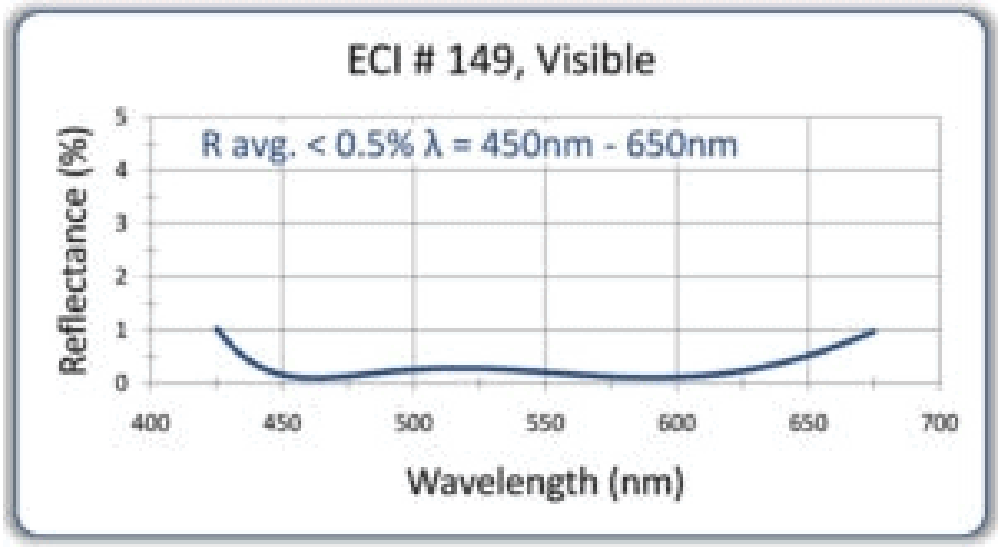
Typical Laser & LED AR Coating Designs for Glass Substrates:

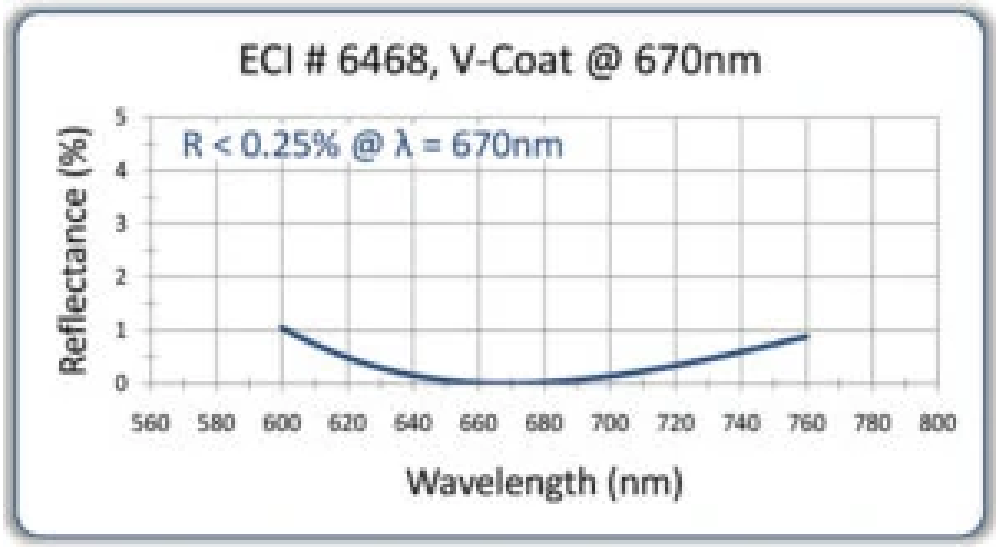


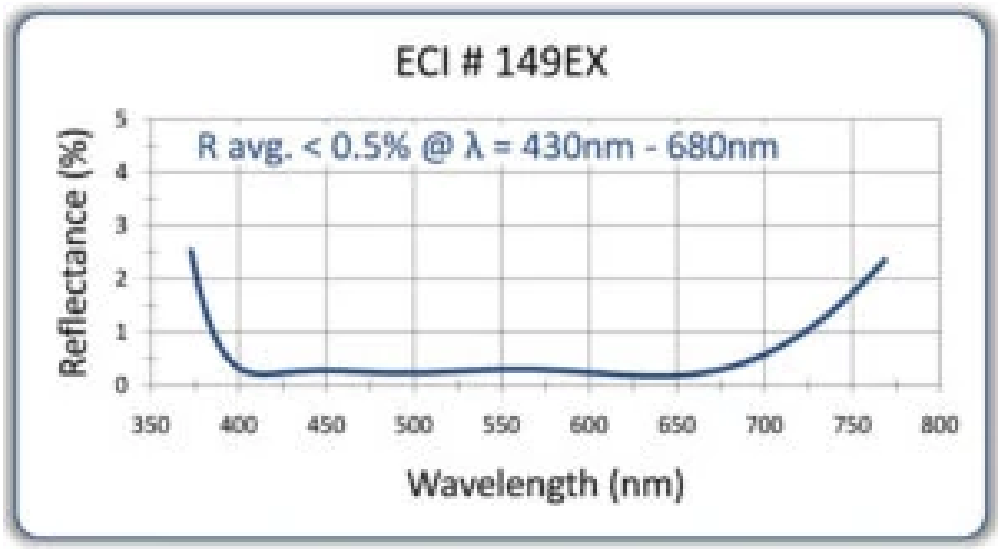




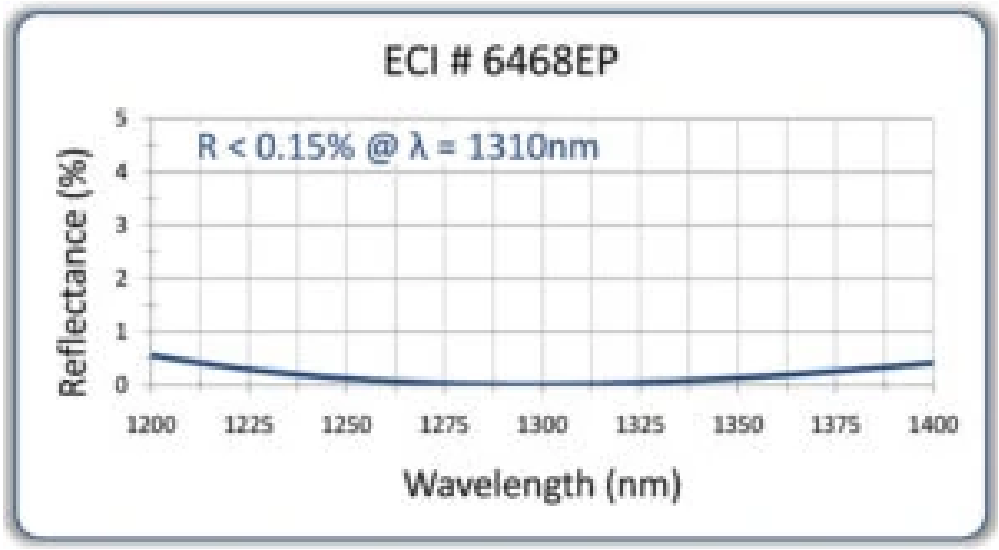
Typical AR Coating Designs for Plastic & Polymers Optics:

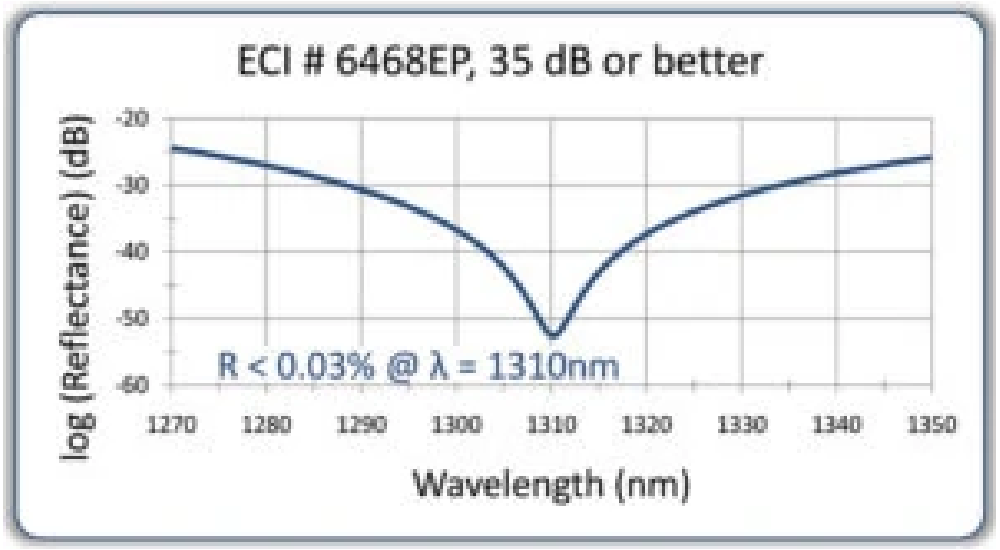


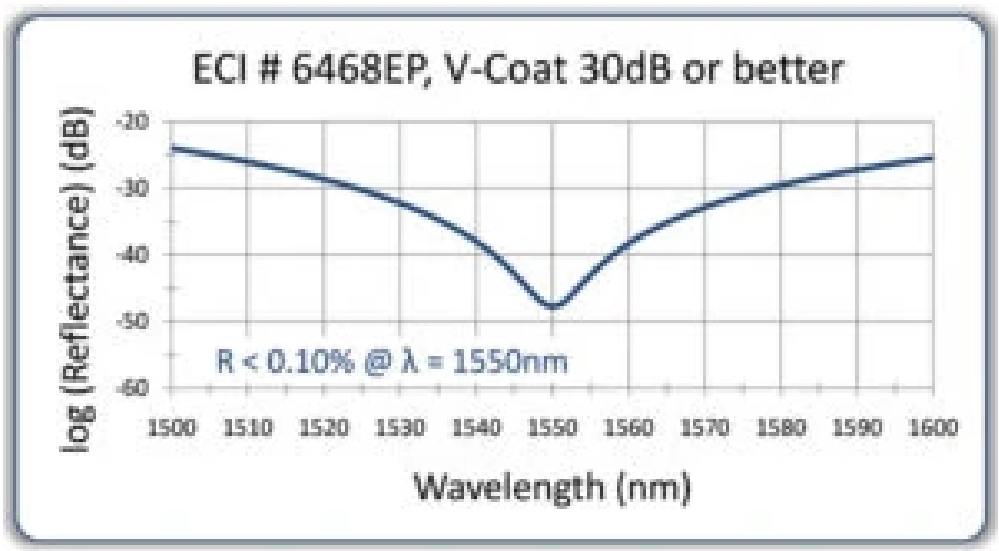


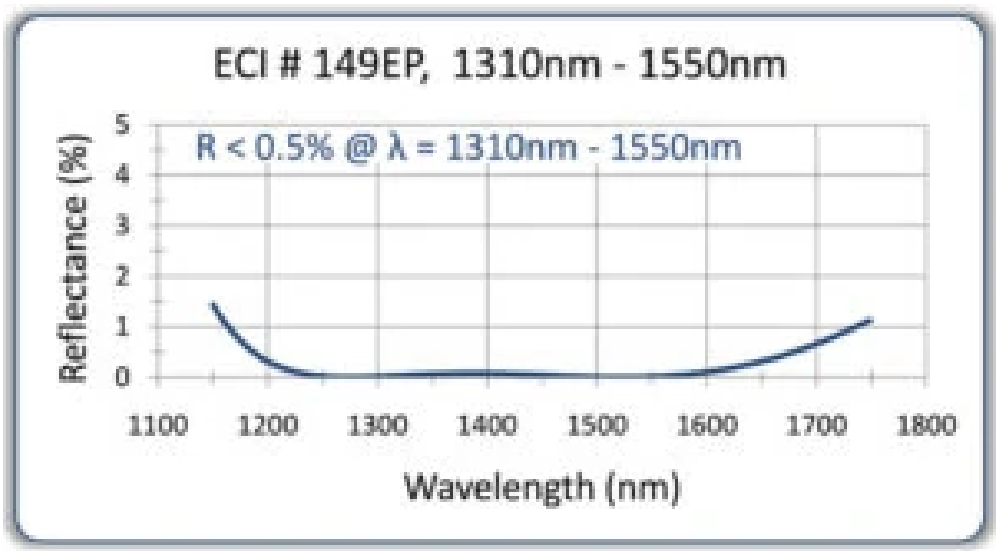


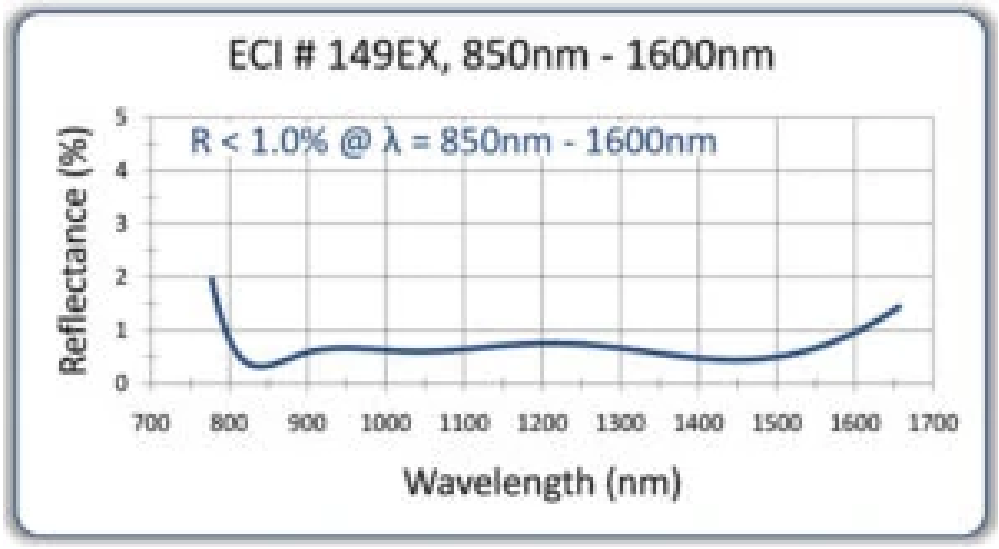
Typical AR Coating Designs for Fibers & FiberOptic Devices:

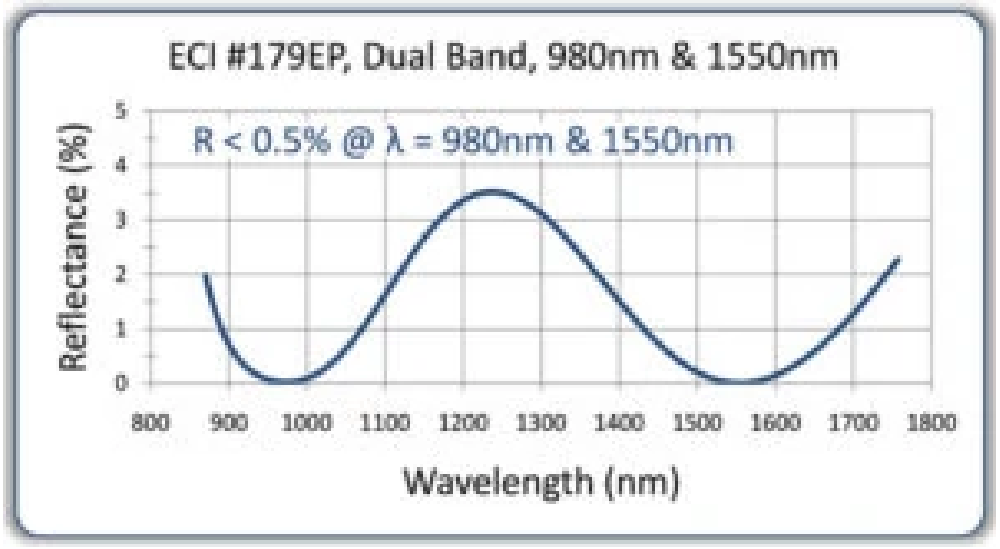


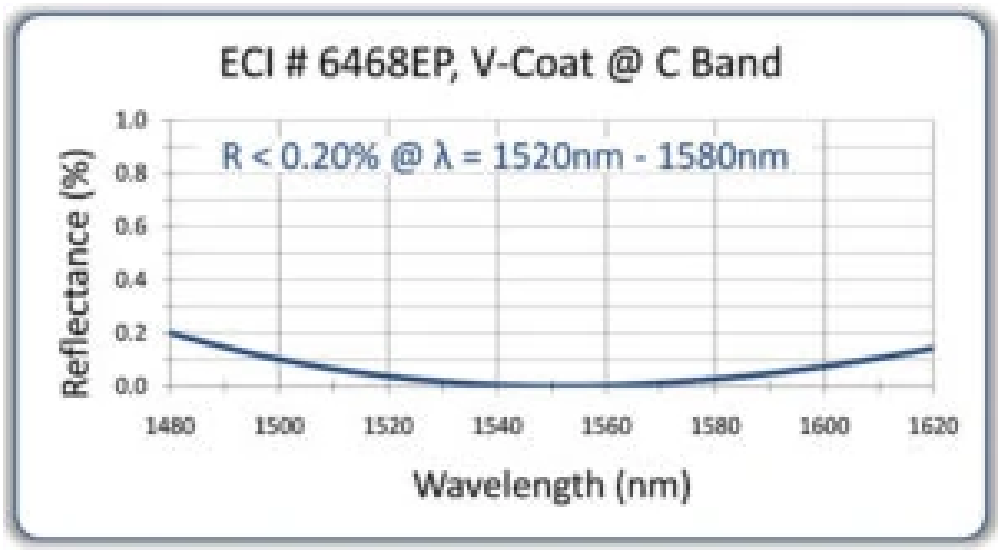


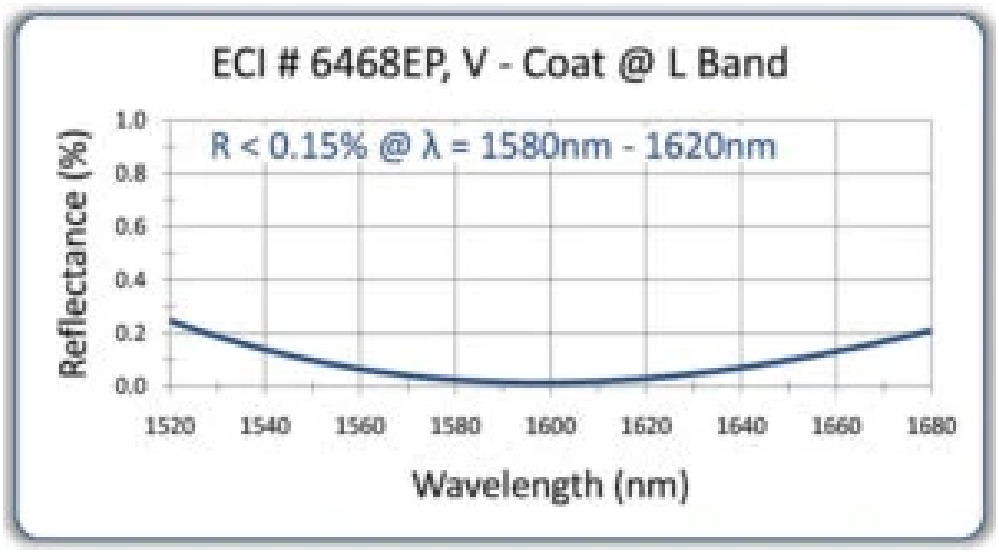


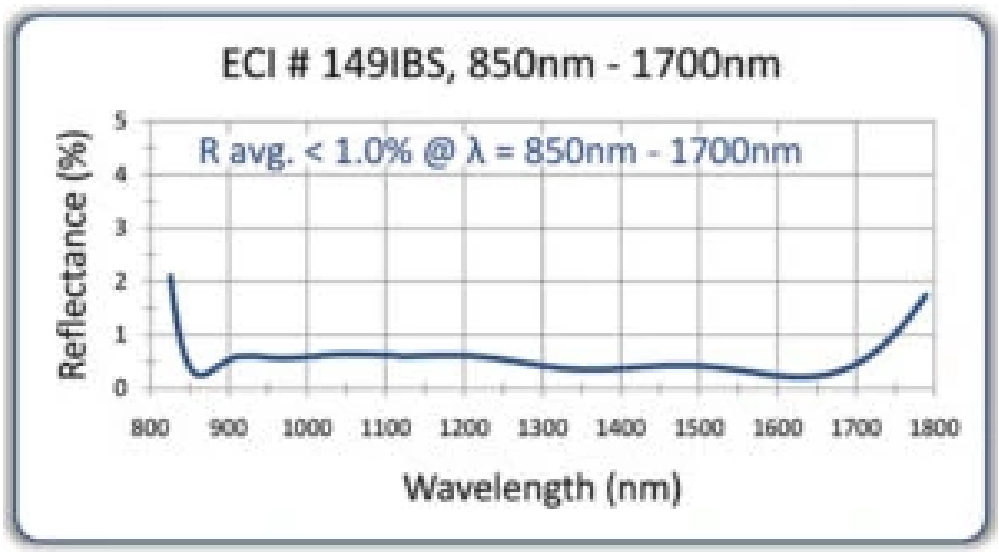




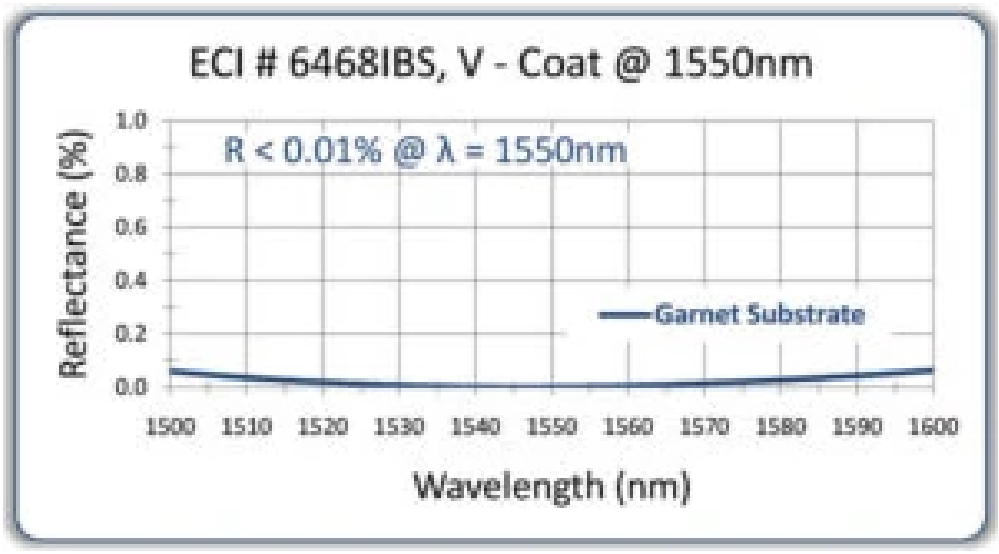


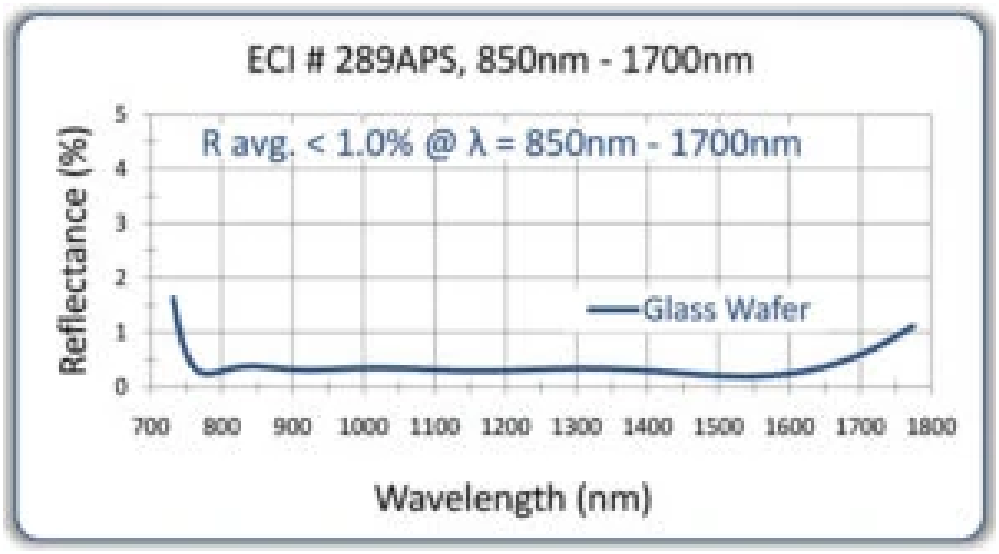


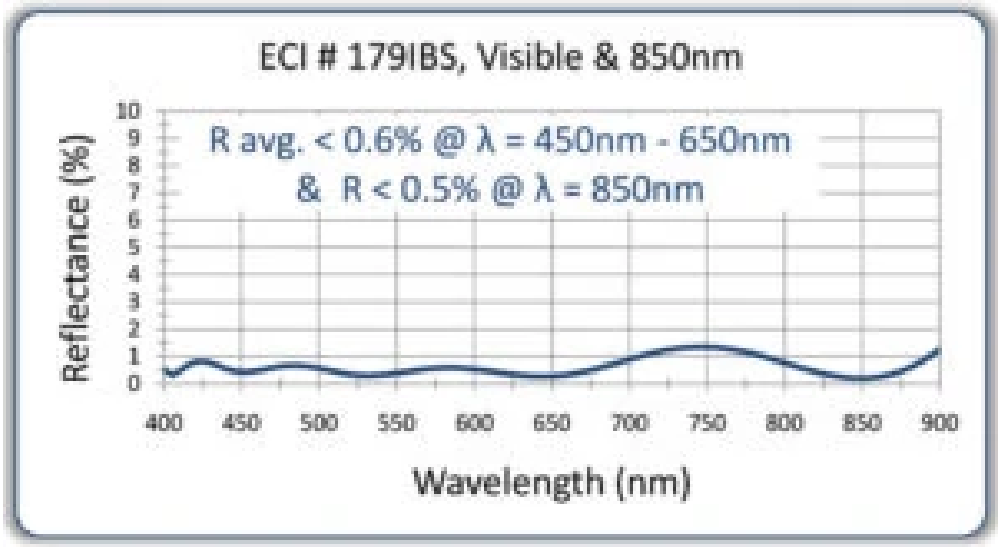


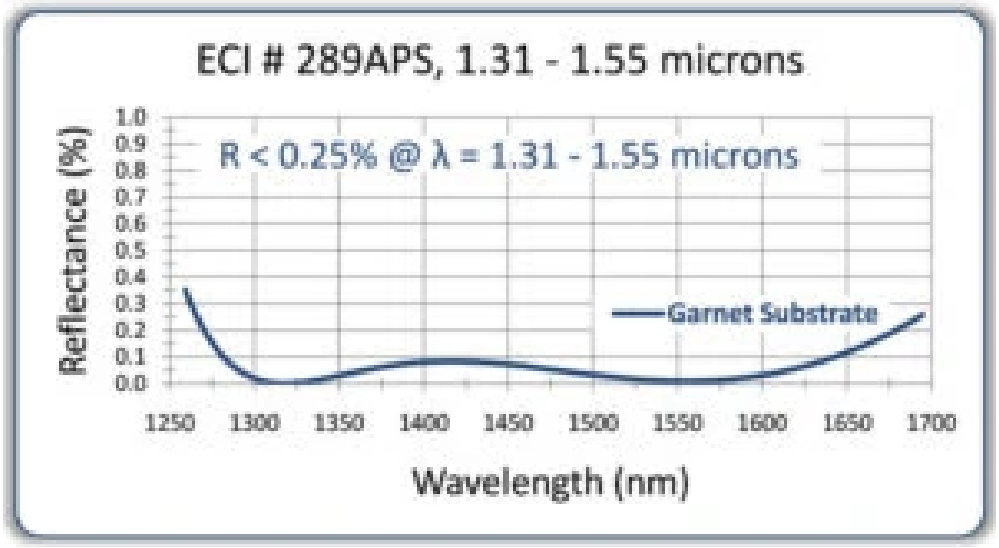


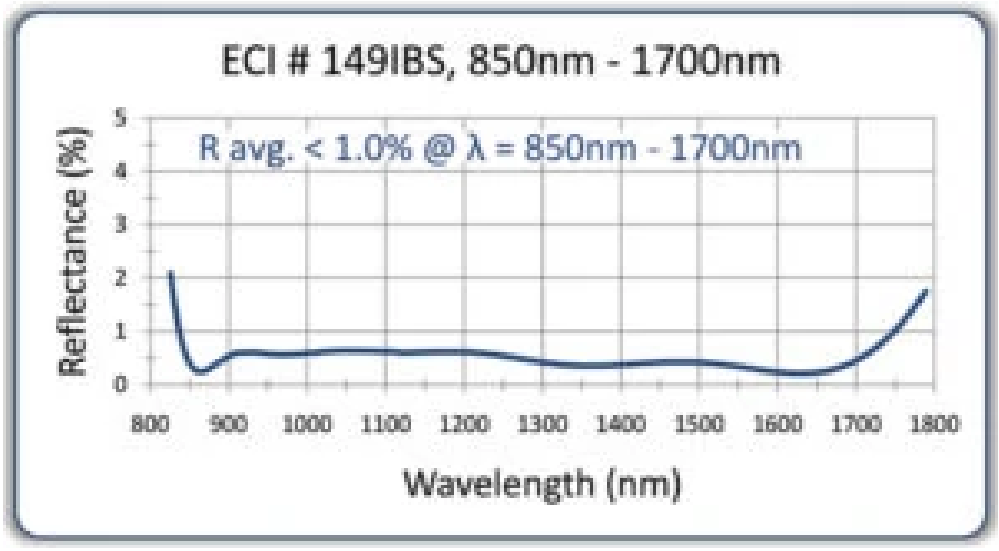
Typical IBS & APS AR Coating Designs for Crystals and Semiconductor Materials:

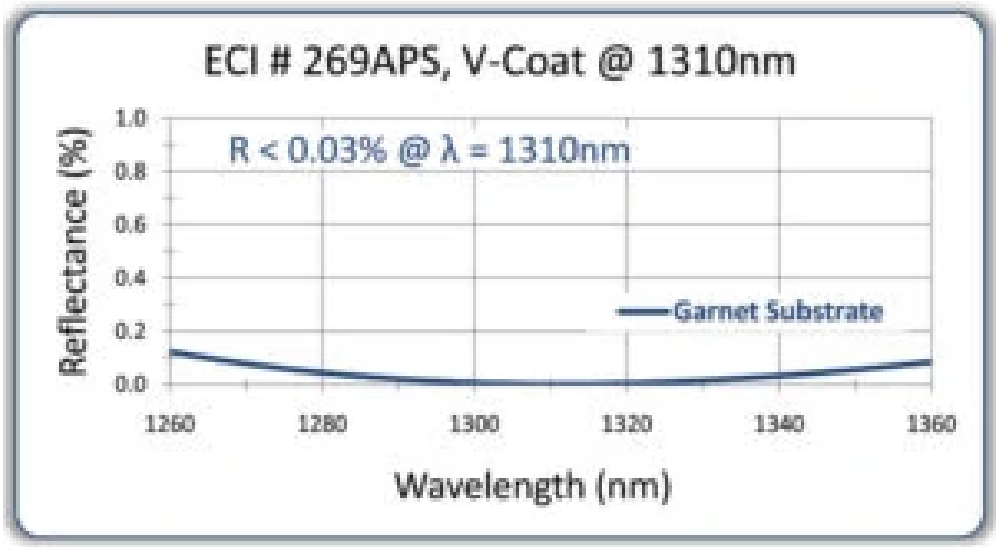




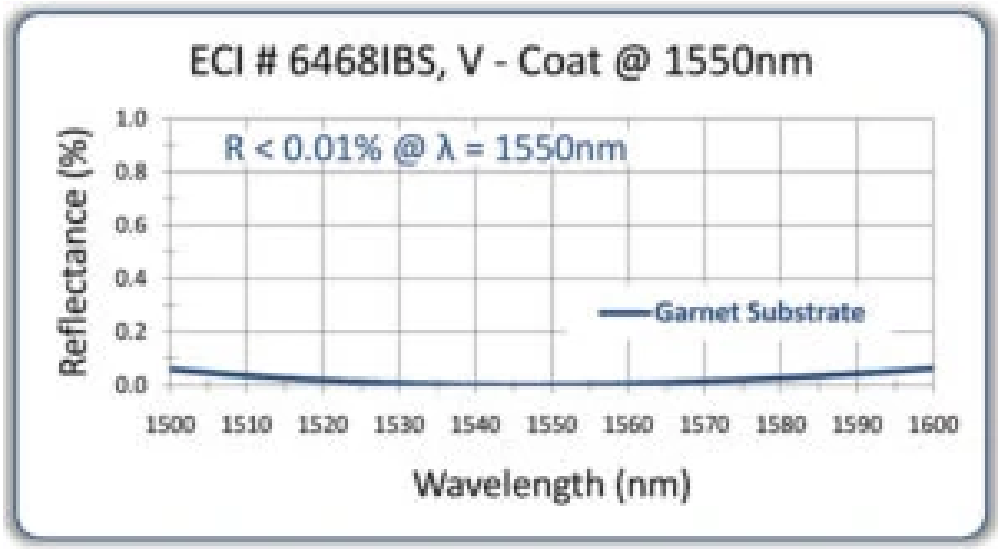


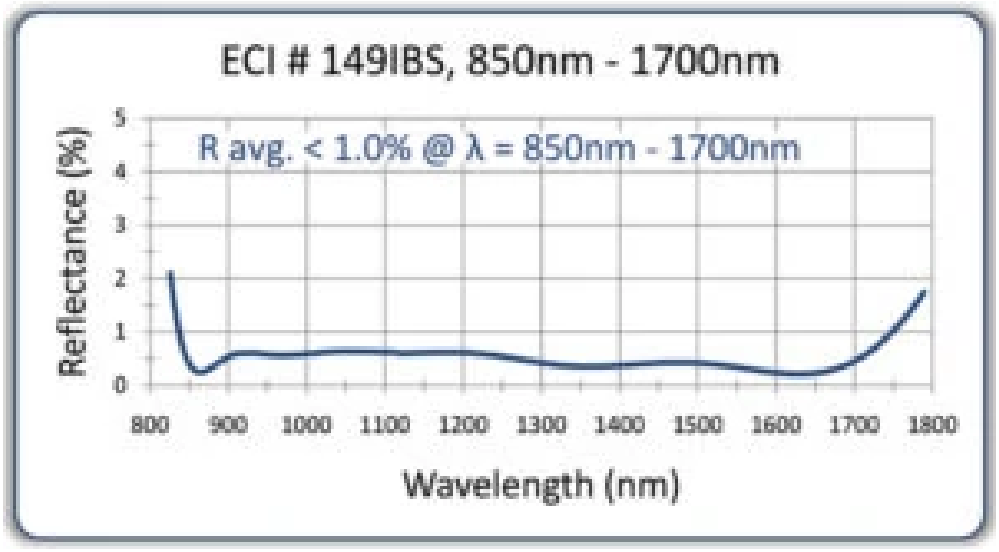


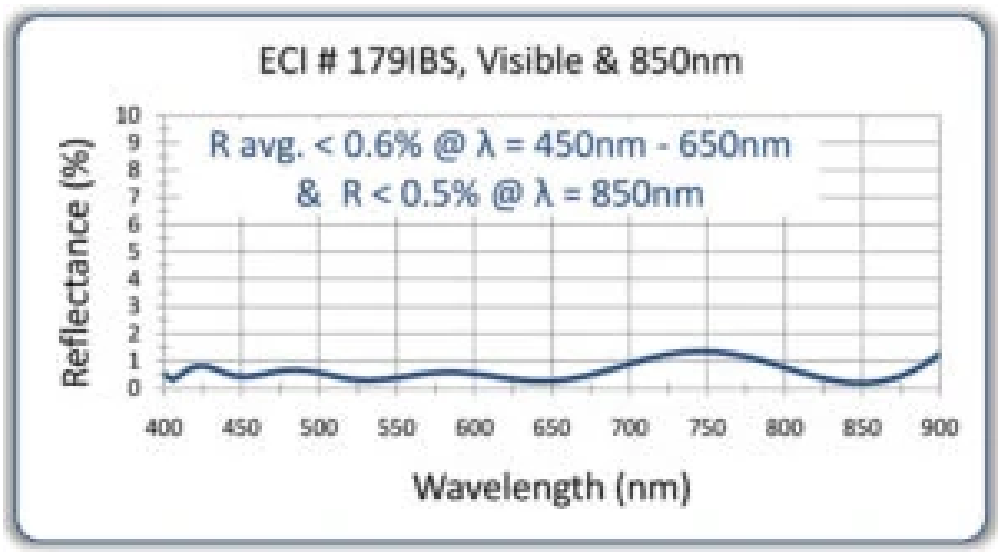


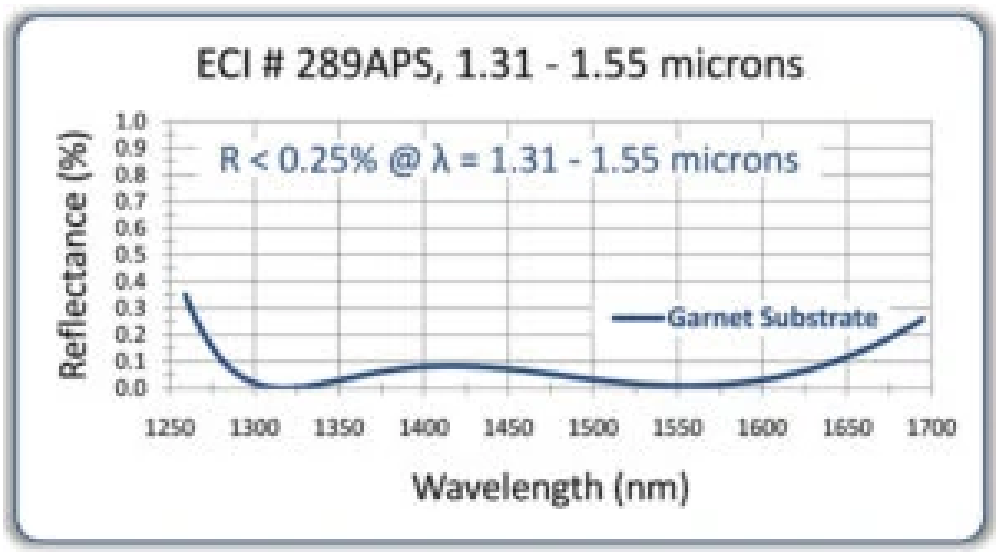


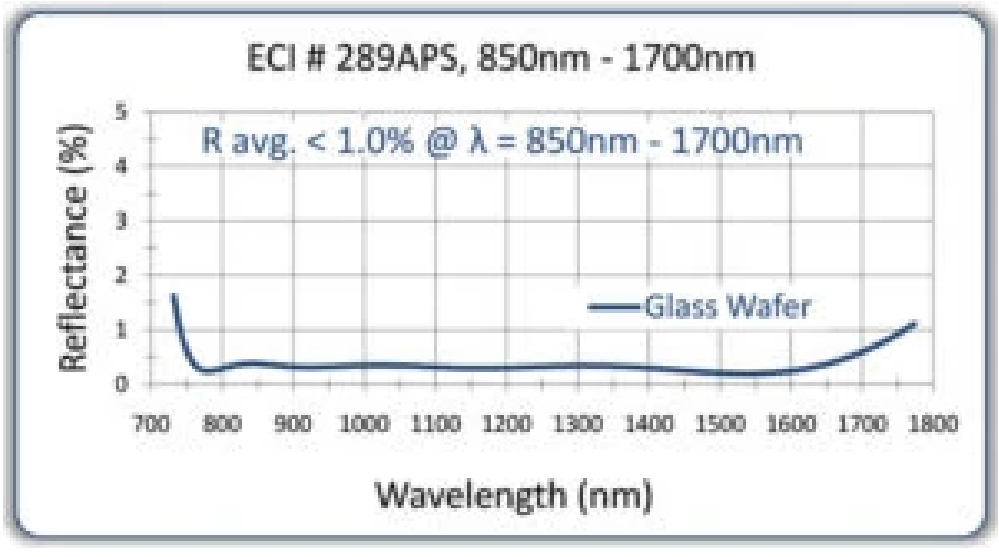
Typical IBS AR Coating Designs:

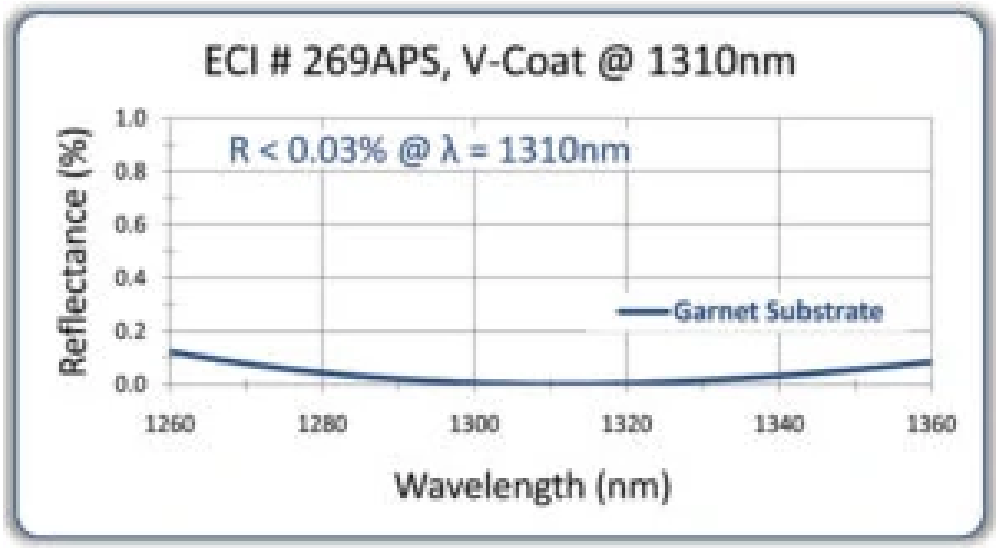












Designs are RoHS compliant.

Contact *one of our Sales Engineers to discuss your specific Anti-Reflection Coating application today!*

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