



# OZ Optics

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## OPTICAL COATINGS

### Features:

- Standard and custom optical coatings available
- Fully automated e-beam ion beam assisted deposition (IAD) technology
- High power handling
- Low temperature deposition
- Hard abrasion resistant dielectric coatings
- Designed to handle large volume of fibers, micro optics, lenses, prisms windows and uncommon size substrates
- Thin film design capabilities for custom applications
- Spectral range 300-2500 nm
- Low and high volume
- On time delivery and competitive pricing.

### Applications:

- Fiber optic applications: sensors, telecommunications
- Lasers, laser spectroscopy, laser to fiber delivery, laser pumping
- Imaging systems, instrumentation optics
- General photonics applications
- Custom requests

### Product Description:

Optical thin film coatings are used to change the spectral transmission and reflection behavior of optical surfaces to produce optical components with desirable spectral properties. Nowadays almost all optical devices have some optical coating applied onto its optical surfaces.

At OZ Optics, we use all-dielectric coating materials and designs that insure virtually no absorption, low loss and no scattering. We specialize in coating high power optical components that are used in a variety of applications and industries. We do this using state-of-the-art fully automated electron beam ion assisted technology for manufacturing.

Below is a brief description of the coatings we produce. We also produce custom designs and runs per customer request.

### Antireflection coatings: laser line, wide band, dual band coatings:

Antireflection coatings (AR) are required to increase light throughput, reduce backreflections and minimize stray light in an optical system over a desired spectral range.

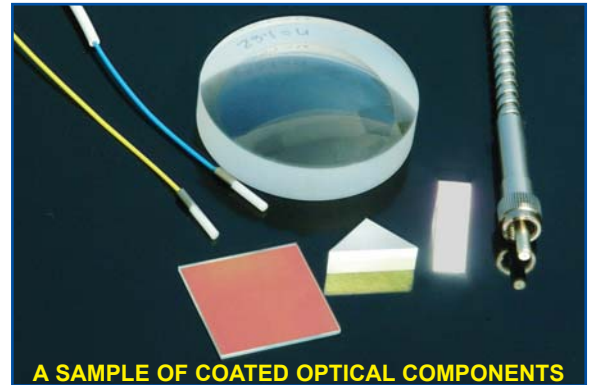
Optical elements including fiber tips, parallel plates, lenses, and prisms are all regularly antireflection coated. A large variety of antireflection coating designs are regularly used and available. These include AR coatings for:

- Major laser wavelengths,
- Dual band (DBAR) antireflection coatings,
- Broadband BBAR antireflection coatings
- Custom designs for user specified spectral regions.

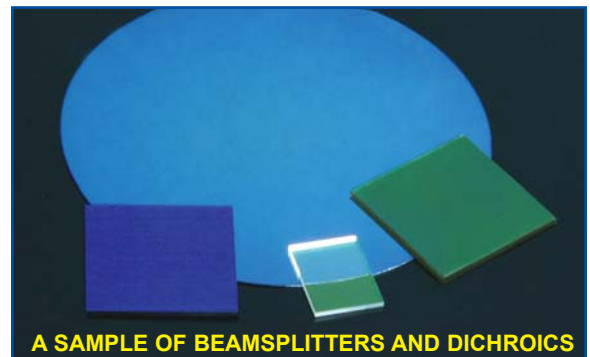
### Plate Beamsplitters, tap coatings, partial reflectors:

**Beamsplitters** are used to split reflected and transmitted light of a given spectral range at a specific ratio and predefined angle of incidence (usually 45 degrees). Examples include 50/50, 70/30, and 90/10 transmission/reflection ratios. This also includes control of the polarization states of the reflected and transmitted beams.

**Tap coatings** are used to transmit light but to reflect (tap off) a small portion of light at usually small angles of incidence (e.g 1.8 degrees). 99/1 and 95/5 are common ratios. These are used in a variety of optical systems to measure and control the amount of light that is exiting the optical device (power monitoring).



A SAMPLE OF COATED OPTICAL COMPONENTS



A SAMPLE OF BEAMSPLITTERS AND DICHROICS

**Longwave and shortwave pass filters (dichroics):**

Longwave and shortwave pass (also called edge filters, dichroic filters) transmit and reflect certain parts of the spectral range. These filters are designed and made for a predetermined angle of incidence (such as 0 or 45 degrees) or range of incident angles (eg. 0-20, 35-50 degrees) depending on the optical design of the device used. They are used for a variety of applications that require beam combining and separation based on wavelength.

One example would be wavelength division multiplexers (WDMs). These devices are used to combine different incoming wavelengths into a single beam. For example, one could combine 532 nm and 633 nm wavelengths into one beam.

**Laser line high reflectors**

High reflector mirrors reflect light over a predefined spectral range. Also, partial reflecting mirrors are made where a fixed portion of the light is transmitted. We focus on coating dielectric high reflectors on custom substrates or on fiber tips for a variety of applications. These coatings feature low absorbance, and high power handling. Typical reflectance is  $R > 99-99.9\%$ .

**Custom optical coatings:**

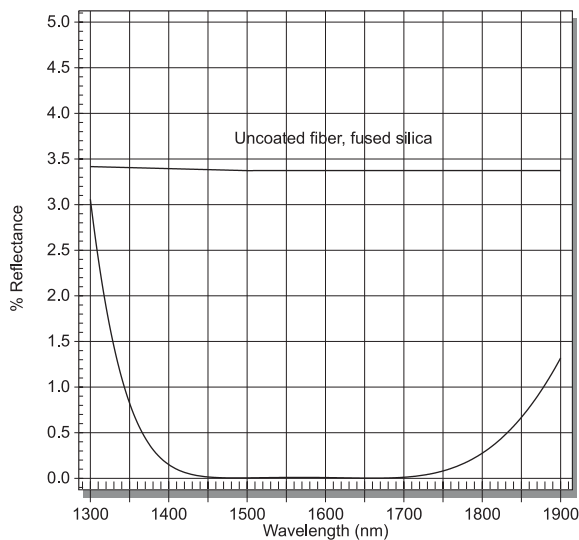
We do custom coatings for a variety of applications. Please send your request. We will send you a proposed design (spectral performance) and quote.

**Standard Product Specifications**

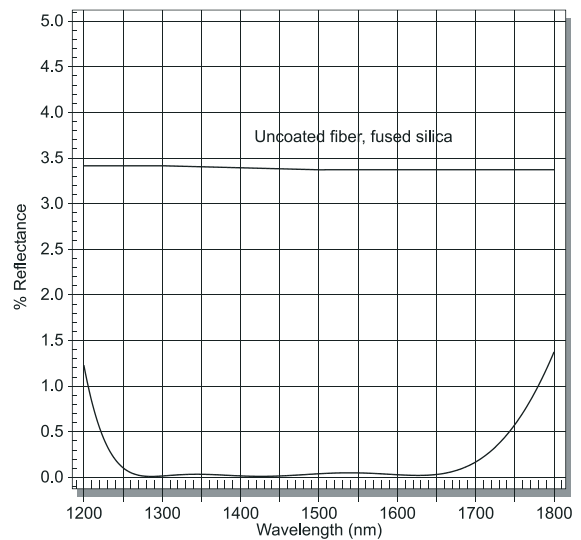
Property	Value	Comment
Substrate material	Bare fibers, ferruled patchcords, connectors, fiber arrays, glass/metal assemblies, V-grooves, GRIN lenses, standard lenses, semiconductor materials, fused silica, any glass	
Laser damage threshold/ Power rating	27 J/cm <sup>2</sup> , 20 nsec pulse width, 20 Hz repetition rate, or 1.2 GW/cm <sup>2</sup> , typical	AR coatings at 1064 nm
	33 J/cm <sup>2</sup> , 20 nsec pulse width, 20 sec repetition rate, or 1.5 GW/cm <sup>2</sup> , typical	Beamsplitters/High reflectors, 1064 nm
Adhesion and durability	Per MIL-C-675 C And MIL-C-48497A	

**Note: OZ Optics** regularly coats low and high volumes of a variety of fiberoptic and photonic components. We also have toolings that can handle most of the standard fiber optic components. OZ optics will recommend packaging/handling methods that minimize handling and reduce cost. Contact OZ Optics to discuss your particular needs.

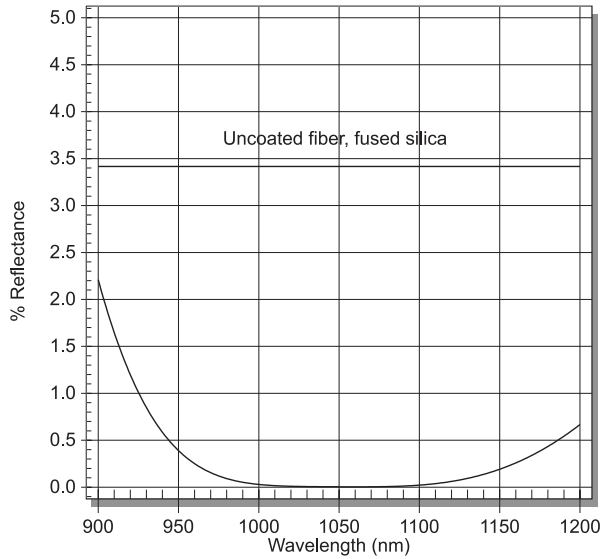
**Sample of antireflection coatings performed regularly**



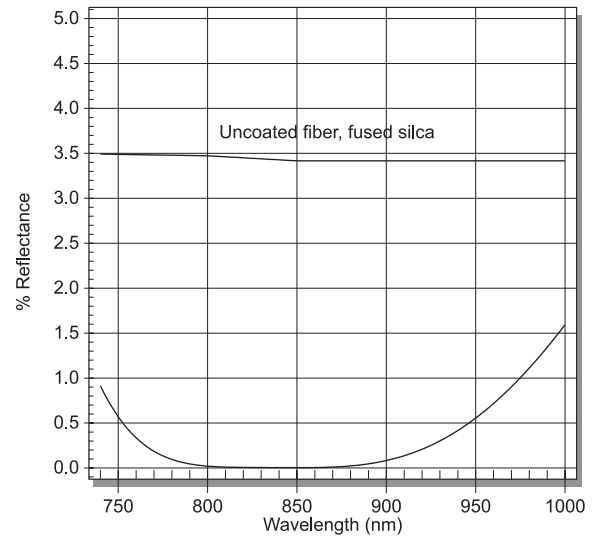
**Figure 1: Antireflection coating for 1500-1650 nm telecommunication spectral range**



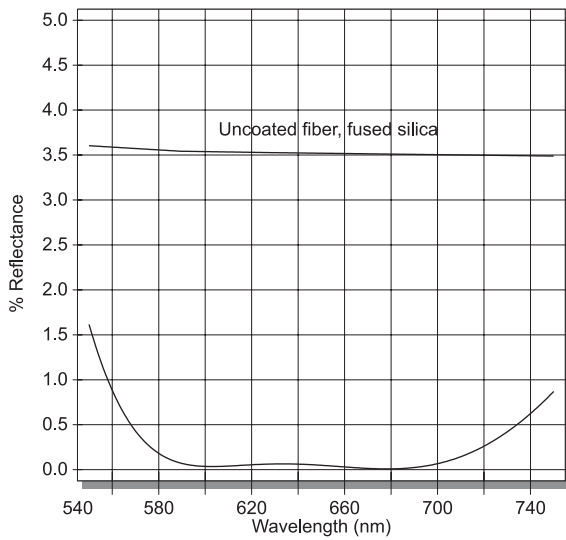
**Figure 2: Broadband antireflection coating for 1280-1625 nm telecommunication applications**



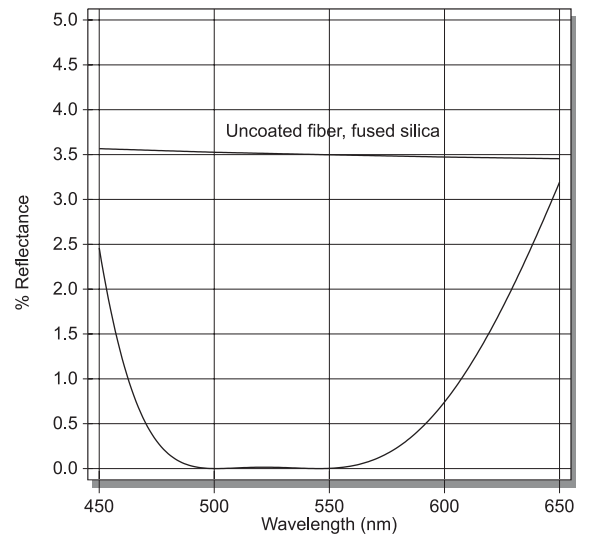
**Figure 3: Antireflection coating for 980-1100 nm, Nd YAG laser and similar applications**



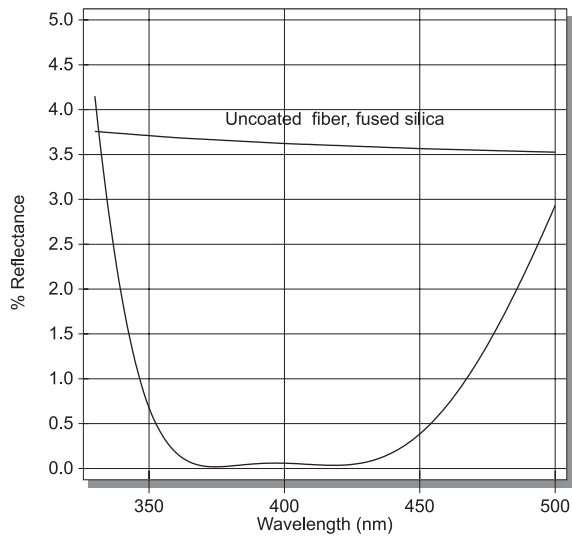
**Figure 4: Antireflection coating for 790-890 nm, diode laser applications**



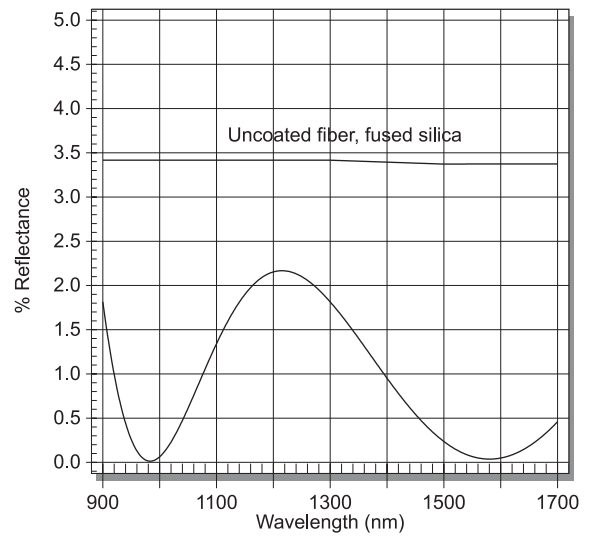
**Figure 5: Antireflection coating for 590-690 nm**



**Figure 6: Antireflection coating for 490-560 nm. Typically used for 532 nm lasers or similar.**



**Figure 7: Antireflection coating for 380-430 nm.**



**Figure 8: Dual band AR coating for 980 nm and 1550 nm.**

## Samples of other coatings we do regularly

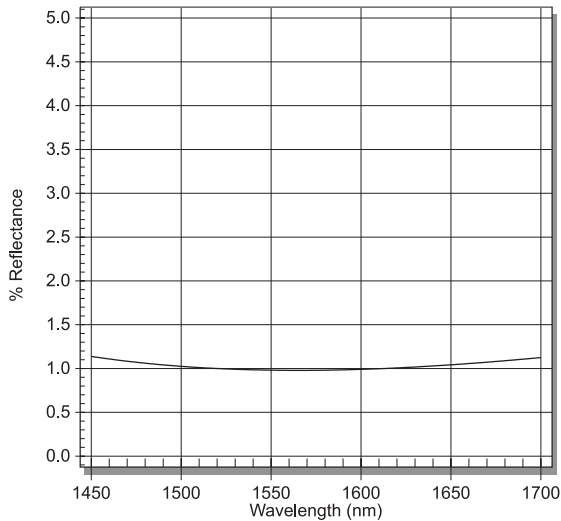


Figure 9: Tap coating, 1% reflectance for 1500-1650 nm

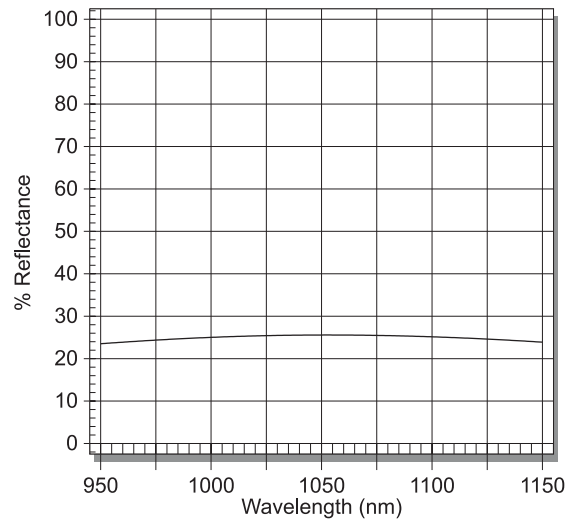


Figure 10: Beamsplitter for 1000-1100 nm, AOI=45 deg. R/T=25/75 %, random polarization

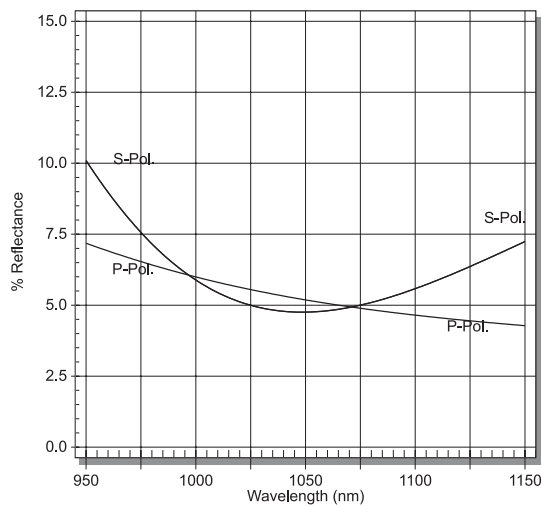


Figure 11: Nonpolarizing beamsplitter for 1064 nm, R/T= 5/95 %, AOI= 45 deg.

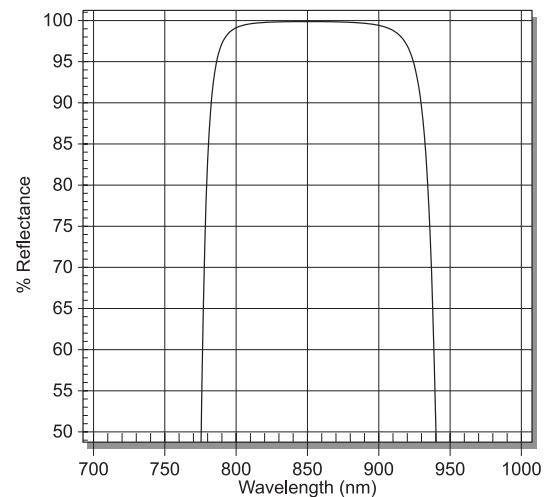


Figure 12: High reflector for 850 nm, normal incidence, R > 99.5%

## Ordering Information For Standard Parts:

Part Number	Description
OC-AR-1500/1650-0.3-0	AR coating for 1500-1650 nm, R < 0.3%, R <sub>typical</sub> < 0.15 %, 0-10 degree AOI
OC-AR-1280/1650-0.5-0	AR coating for 1280-1650 nm, R < 0.5%, R <sub>typical</sub> < 0.3 %, 0-10 degree AOI
OC-AR-980/1100-0.3-0	AR coating for 980-1100 nm, R < 0.3%, R <sub>typical</sub> < 0.15 %, 0-10 degree AOI
OC-AR-790/890-0.3-0	AR coating for 790-890 nm, R < 0.3%, R <sub>typical</sub> < 0.15 %, 0-10 degree AOI
OC-AR-590/690-0.3-0	AR coating for 590-690 nm, R < 0.3%, R <sub>typical</sub> < 0.15 %, 0-10 degree AOI
OC-AR-490/560-0.3-0	AR coating for 490-560 nm, R < 0.3%, R <sub>typical</sub> < 0.15 %, 0-10 degree AOI
OC-AR-380/430-0.3-0	AR coating for 380-430 nm, R < 0.3%, R <sub>typical</sub> < 0.15 %, 0-10 degree AOI
OC-DBAR-488/976-0.5-0	Dual band AR coating for 488 nm and 976 nm, R < 0.5 %, 0-10 degree AOI
OC-DBAR-980/1550-0.5-0	Dual band AR coating for 980 nm and 1550 nm, R < 0.5 %, 0-10 degree AOI

## Ordering Examples for Standard Parts

A customer needs to coat fibers for 825-870 nm. Angle of incidence is 0+/- 10 deg. A reflection level of < 0.3% over this range is acceptable. The coating required for this will be **OC-AR-790/890-0.3-0**.

Part Number	Description
OC-AR-790/890-0.3-0	Antireflection coating for fibers to cover spectral range 790-890 nm.

## Questionnaire for Antireflection Coatings:

1. What type of device do you require to be AR coated?
2. What is the wavelength range you need AR coating for and tolerance?
3. What is angle of incidence and associated cone of angles (if applicable)?
4. Specify any power handling requirement.
5. Specify any specific environmental requirements.

**Note:** If you have other needs please specify this before ordering.

## Ordering Of Custom Parts For Other Coating Types:

### Questionnaire for custom parts:

1. Specify your application.
2. Describe your substrate (if you are providing it). Provide sizes and tolerances.
3. Please specify spectral range and specification for the coating performance that you are looking for, including any polarization requirement and include angle of incidence.
4. What power levels will this component be subjected to? For laser applications specify laser conditions.
5. Specify angle of incidence.
6. Specify surface quality.

## Frequently Asked Questions (FAQs):

**Q:** What wavelength range for coating is available?

**A:** We cover 300-2500 nm spectral range.

**Q:** Can you custom design coatings for our application?

**A:** Yes, we'll be glad to provide custom thin film designs. Keep in mind that for custom size parts a non-recurring engineering charge may be necessary to cover the cost of special tooling needed to hold parts during the coating process.

**Q:** Do you send spectral graphs with parts that have been coated?

**A:** We send a certificate of compliance for all manufactured parts. However if a customer demands a spectral graph to accompany the shipment we will do so. All deposition runs are traceable and we keep a library with all spectral measurements and associated witness pieces for a minimum of 2 years.

**Q:** What spectral testing do you perform?

**A:** OZ Optics uses top of the line Perkin Elmer Spectrophotometers with a variety of attachments for transmittance and/or reflectance measurements at a variety of incidence angles. Also, we use depolarizers and polarizers for testing optics for random, s and p polarizations.

**Q:** What is the power handling of your coatings?

**A:** OZ Optics specializes in coatings that can handle very high power. Special coating materials, substrate preparation and deposition technology are used for this purpose. Power handling of our coatings are independently tested. Please keep in mind that the power handling of the coated optics depends on many factors after the optics is coated and delivered (optic cleanliness, conditions of use, laser/power stability etc.) . Therefore we provide power handling data as a guideline only to what power levels our coatings can be used without permanent damage.

**Q:** Power handling is specified for pulsed lasers but my application is CW. What does this affect?

**A:** There is no widely acceptable test for CW power handling. While the pulsed test is performed using a test method that is close to ISO 11254, only an estimate is provided for CW power handling. However, higher pulsed test data usually means better CW power handling of the optics.

**Q:** Power handling data is provided for 1064 nm. Do you have data for other wavelengths?

**A:** Coating laser power handling testing is not simple and cheap. We provide testing data for 1064 nm and more data will be provided soon. However keep in mind that power handling data approximately scales with wavelength, so the higher the wavelength, the higher the power handling and vice versa.

## Application Notes:

### Antireflection coatings:

The simplest and most frequent application of AR coatings is to increase light throughput through optical systems.

**Example:** An uncoated fused silica, plate, lens or fiber, reflects approximately 3.5 % of the light due to Fresnel reflection (mismatch of refractive index between fused silica (1.46) and air) per uncoated side. This means that 7 % of the light is reflected from an uncoated silica plate while 93 % is transmitted.

By applying an AR coating on both sides this is usually reduced to 0.1-0.3 % per coated side, therefore increasing light throughput to approx. 99.5 % and reducing reflections.

### Ion assisted deposition:

Our deposition process is based on ion assisted electron beam deposition using cryopumps for vacuum pumping.

Cryopumps ensure high pumping speed, low vacuum levels, and a contaminant free environment for deposition. This is very important for achieving coatings that can handle high power.

While the deposition of the dielectric material is performed by electron beam gun, an ion gun produces energetic ions that enhance the energy of the coating material being deposited onto the substrate. This in turn improves thin film properties such as:

- increasing the density of the deposited material
- reducing the porosity and moisture adsorption
- enhancing adhesion
- enabling coating stress reduction and stress control for special applications

Optical thin films deposited using this deposition technique produce low scatter amorphous films.

Another advantage of this process is that it enables us to perform ion/plasma cleaning of the substrates prior to thin film deposition. This process uses low energy ions of either argon or oxygen or an appropriate mixture of these gases to clean substrate surfaces by removing any residual hydrocarbons, water vapor or other adsorbed materials to significantly improve coating adhesion and durability.