Optical Coatings on Engineered Plastic Applications

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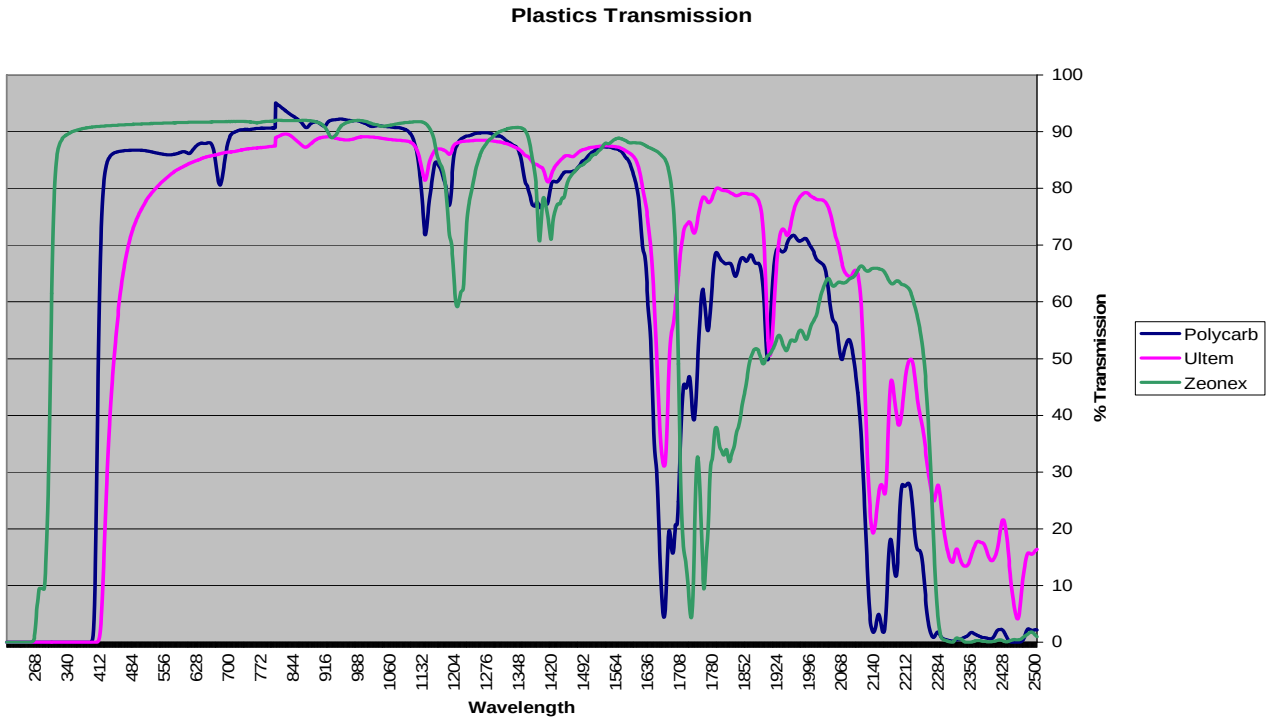
DSI has introduced the capability of manufacturing durable coatings on a group of engineered plastics. The current plastics for which coating methodologies have been developed are Ultem®, Zeonex, and various forms of Polycarbonate. Each of these materials has unique properties that make them suitable for different applications. Of the three families of plastics Ultem® has the highest glass transformation temperature, 392ºF. This makes it suitable for applications where thermal load is potentially an issue, for example applications such as LED fixturing, solar concentrator mirrors, and conventional lighting fixtures. Zeonex has the best injection molding properties. Optics injection molded Zeonex yield fine features and exhibit excellent transmission and clarity. Zeonex has a relatively low index of refraction ~ 1.54 @ 550 nm and a moderate glass transformation temperature as high as 139 °C for some formulations. Polycarbonate has excellent mechanical strength allowing it to be used in larger optics such as mirror blanks. Polycarbonate is available in many forms including low fluorescing forms in gray and black. These forms are well suited as mirror substrates for bio detection systems.

The use of plastic as an optical material adds a great deal of flexibility for the optics designer as well as the potential for cost reductions in the system. Plastic optics can be molded with mounting features as part of the optic, reducing the need for intricate mounting schemes in the optical system. Small parts can be molded in a web with multiple parts contained in a single unit. This reduces handling in the coating process which leads to cost savings and reduces the possibility of loss in the coating operation.

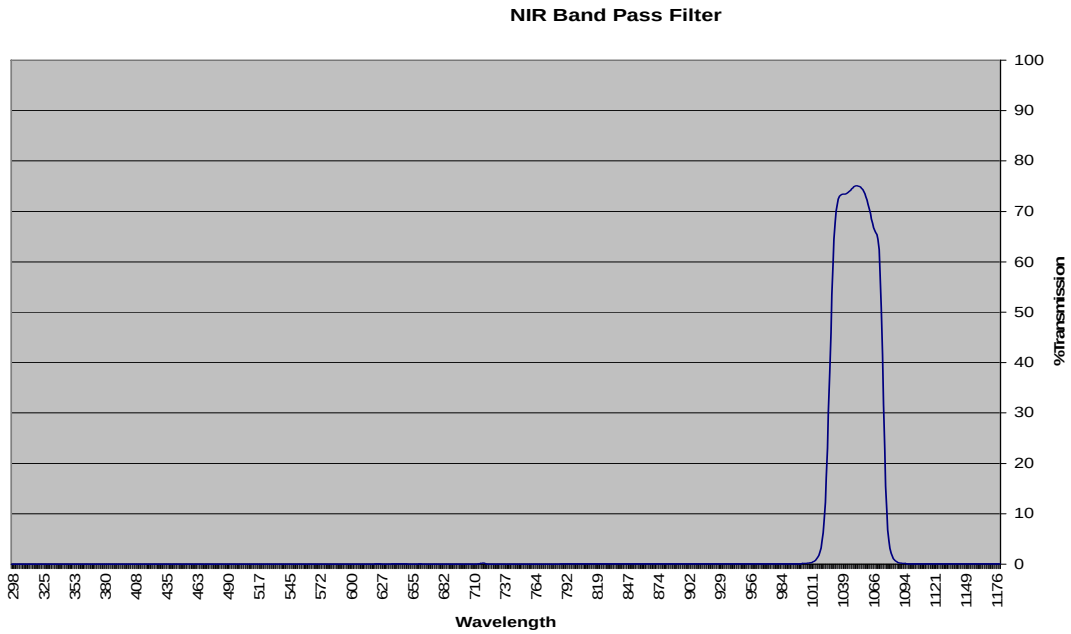
Figure 1 is a transmission scan of the three families of plastic. The scan of the Ultem® material is from a piece that is 1.0 mm thick. The Zeonex and the Polycarbonate are scans from material that is 3.0 mm thick. All three materials exhibit reasonable transmission in the visible spectrum (the scans include Fresnel losses from two surfaces). Transmission in the near infra-red is high until 1080 nm for each material. There appears to be significant absorption bands beyond 1080 nm. Laser damage threshold of each of these materials is unknown.

Figure 1



A wide range of coatings can be applied to the different substrates. Figure 2 is a Near Infra-red band pass filter used in a communications system. The band pass serves to reject wavelengths close to the communications band while yielding good transmission in the laser band of interest.

Figure 2



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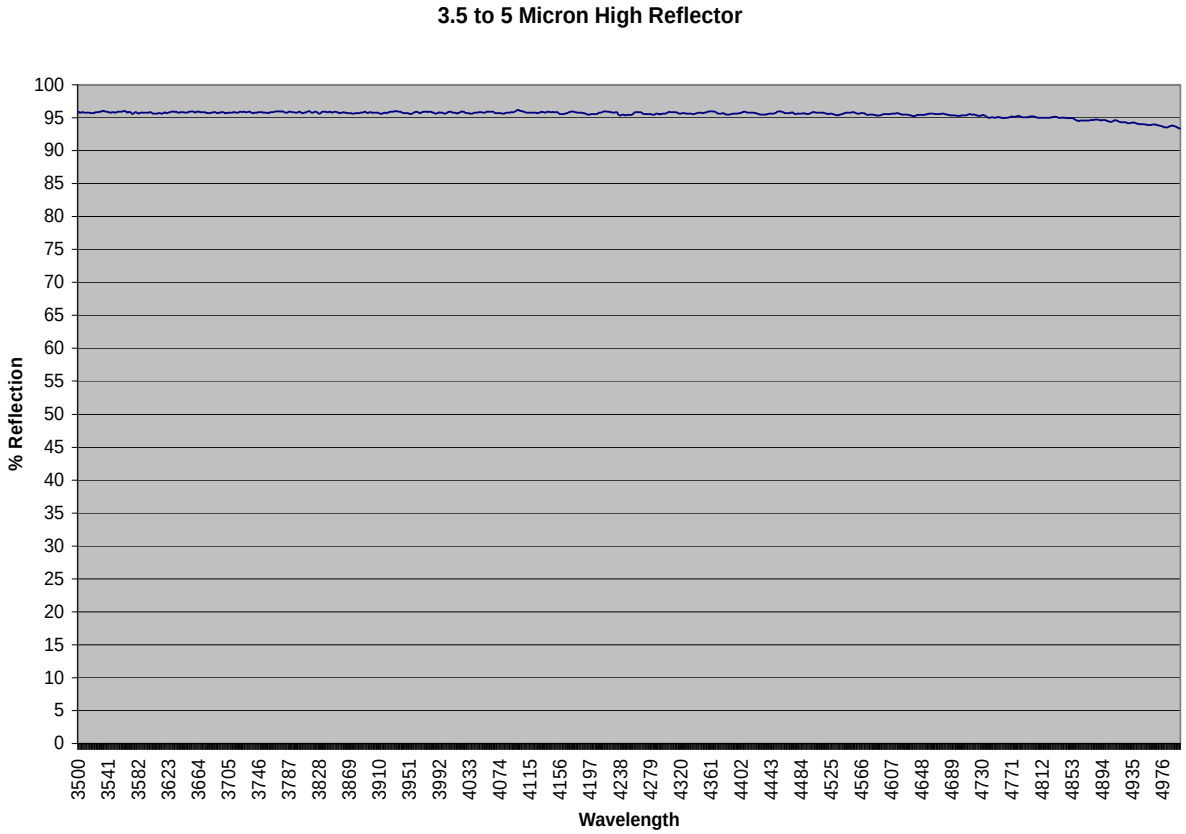
High reflective thin films can be successfully deposited onto plastic optics. Figure 3 shows the results of a 3 µm to 5 µm high reflector deposited onto a Zeonex substrate. This was a prototype optic for a UAV sensor suite application.

Figure 3



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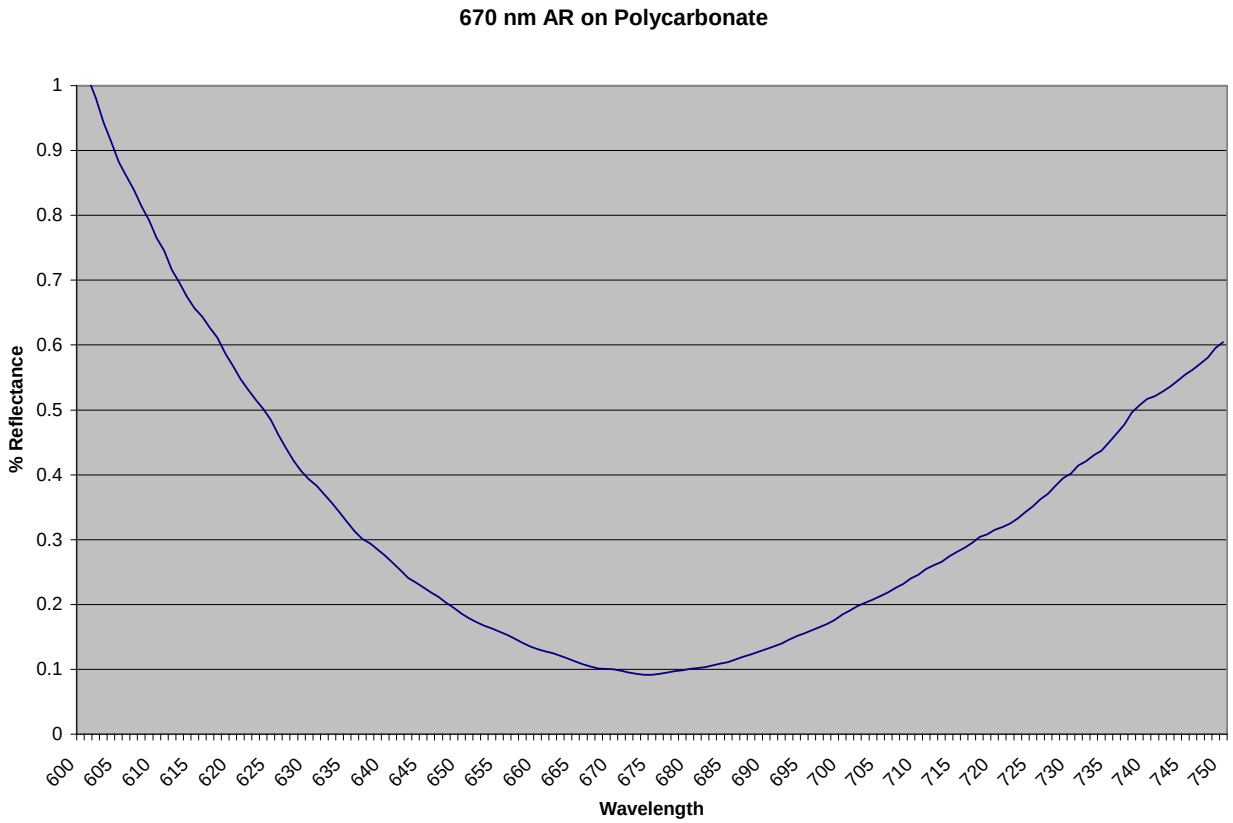
Many of the plastics above can be injection molded into complex lens shapes. However even with the low index of some of these plastics they can still benefit from the addition of an anti-reflection coating on the lenses. Figure 4 shows the performance of an AR coating on a Polycarbonate optic. The coating was optimized for a laser mouse application. The graph shows low reflectance at the target wavelength of 670 nm.

Figure 4



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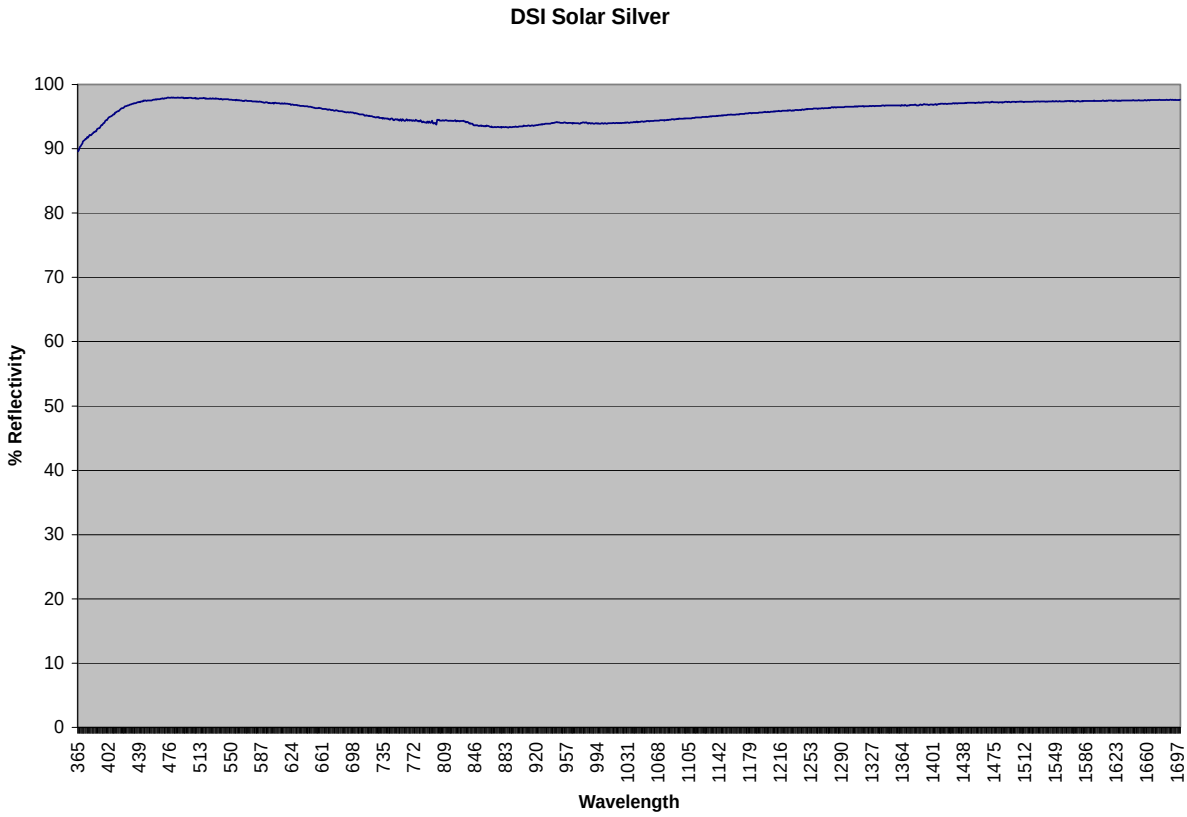
DSI has successfully applied a durable silver coating to several of the above plastic types. In this case a proper adhesion layer needs to be chosen that is specific to the plastic being coated. However once this adhesion layer has been identified the silver coating is highly reflective and extremely durable. Figure 5 shows the reflectivity of DSI Solar Silver when coated on a Polycarbonate substrate.

Figure 5



This silver coating has been designed to maximize the output of a triple junction solar cell. The reflectivity in the deep blue/near UV has been enhanced using several dielectric layers. The dip in reflectivity near 900 nm is also part of the coating design. This coating balances the amount of energy produced by each junction of the cell to maximize cell power output.

Prior to choosing a plastic to be coated in an optical system there are several parameters that need to be considered. As a general rule the higher the glass transformation temperature of the plastic the better for the coating operation. If the system will require complex thin films, very high reflection, or long wavelength operation, this will require a longer time in the coating chamber. This extended period in the coating chamber may result in a higher temperature at the end of the coating run.

Plastics do not have the same rigidity as glass. Optical thin films can have a significant amount of intrinsic stress. This intrinsic stress must be considered during initial system design. DSI has developed processes to minimize the stress in a thin film; however engineering effort may be required to minimize this stress.

Our durable plastic coating applications are not only cost effective for our customers, but they are extremely diverse in their application to any optical system. At DSI we are continually pushing the envelop in the engineering and manufacturing of coating solutions for every customer's needs.

For Further Information:

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