Optical Thin Film Coatings Provide Safer Flight Conditions

By Precision Glass & Optics

Specialized thin film optical coatings are currently being designed into customized displays that serve to modify the viewing angle and eliminate unwanted stray light that would otherwise distract the pilot(s) and crew in commercial and military aircraft cockpits.

The precision optical coatings, customized by Precision Glass & Optics (www.pgo.com – Santa Ana, CA) are integrated into specialized light-emitting diode (LED) displays that are then installed into military and commercial cockpits (*Figure 1*). The operational wavelengths and requirements are carefully customized for sensitivity to nighttime lighting conditions. PG&O's design for a precision filter makes it easier for a pilot to read indicators and displays in all lighting conditions, even at night. This advanced technology resolves what has formerly been a very serious challenge in military and commercial cockpit display/lighting ergonomics.

Figure 1: Precision Glass & Optics' customized optical coatings for avionic displays (Photo courtesy of PG&O).

As seen in the 4/6/2011 edition of the Photonics Online (www.photonicsonline.com) newsletter.

PG&O developed the new design to provide precision, narrow cone-angle optical filters for the largest independent manufacturer of LED-based display technology in the world, they had a range of wavelength requirements and transmission specifications that had to be met for the avionics display project.

The filter(s) also need to operate in a military aircraft cockpit environment where extreme temperatures can range from -55°C to +85°C.

The optical filter cutoff is designed to transmit blue, green, yellow, and orange spectral bands, and reflect red spectral bands (see *Figure 2*). It is a complicated thin film multilayer coating process consisting of a dozen or more of dielectric materials with high and low refraction indices (for example, TiO2 and SiO2, respectively). The filter design, i.e. the number of layers, the thickness of each layer, and the order in which they are layered, is created with the aid of special thin film design software called TFCalc. The software optimizes the number of layers and their thicknesses while meeting the required filter specifications and tolerances with a minimal number of layers.

The thin film coating is deposited on a glass substrate that is heated up to 200°C – 250°C in a high pressure vacuum (below 10^{-5} torr) via the material electron beam reactive evaporation in oxygen. Low-energy, ion-beam assisted deposition (IBAD) allows for durable filters without absorbance and scattering losses as well as high mechanical and chemical resistivity for both lab and field applications. A high volume coating chamber (72" dia.) allows the production of thousands of filters in the same coating run. The filter substrates are located on the tooling with double planetary rotation providing deposited layers thickness high uniformity about 1% over substrate holder about 60"diameter.

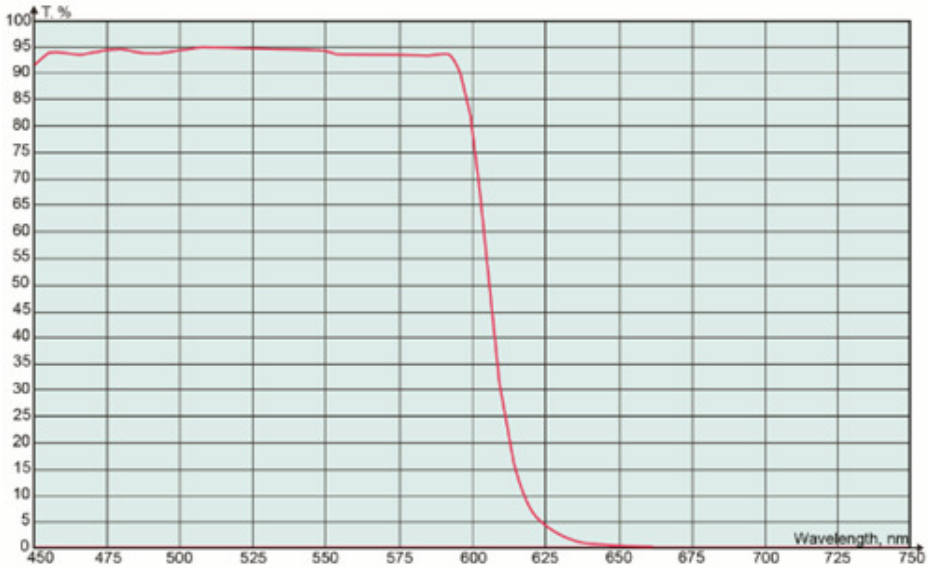

Figure 2: Typical results from coating, measured on PG&O's Perkin Elmer Lambda 950

The filter performance strongly depends on each thin film layer thickness and refraction index accuracy, uniformity, and repeatability from layer-to-layer and from run-to- run. An optical thin film monitor and quartz crystal deposition controller are used to monitor the deposition rate and film thickness. Optical monitoring allows for the control of the thin film layer optical thickness nd (n – material refraction index, d – physical layer thickness), which is the main parameter of optical thin film. A quartz crystal deposition controller allows for the monitoring of the material deposition rate and the deposited film physical thickness, keeping the deposition rate constant during the evaporation process. High precision monitors and controllers permit high accuracy and repeatability of both the coating parameters and the coating runs.

The glass substrates are inspected for surface quality before coating; the produced filters pass through quality inspection, including spectral measurements, abrasion, and adhesion tests in accordance with MIL specifications. All operations with substrates and coated filters are executed in a cleanroom environment.

In addition to custom coatings for avionic displays, Precision Glass & Optics offers other high quality thin film coatings for military, aerospace, solar, biomedical, and industrial applications. These include antireflection (AR), dielectric and metal mirrors, beamsplitters, neutral density filters, indium-tin oxide, or ITO (transparent electro-conductive coatings), and more (*Figure 3*).

Figure 3: A variety of Precision Glass & Optics' precision optics for military applications.

Precision Glass & Optics also offers fabrication services, including the new abrasive waterjet technology, laser engraving, annealing, CNC machining, drilling, double-sided grinding and polishing, diamond bandsawing, slicing, and scribing. Polishing capabilities (up to 36 inches diam.) typically reach flatnesses to λ/20, parallelism to 1 arc second, and tolerances to ±.0005 inches. Chemical and thermal tempering are also used to meet the most stringent part-strengthening requirements. PG&O's thin film optical coatings capabilities include three chambers, one that enables coatings up to four, 24-inch diameter substrates.

About the Company:

Precision Glass & Optics – www.pgo,com – PG&O has delivered excellent quality glass, optics, and optical coatings for a variety of applications for over 25 years. The company offers an extensive materials inventory plus a full optical fabrication shop, three large coating chambers, and an expert, in-house engineering staff, for added convenience. Our cost-effective and reliable optics and advanced thin film coatings are ideal for military, aerospace, biomedical, imaging, laser, digital camera, solar markets, and more.