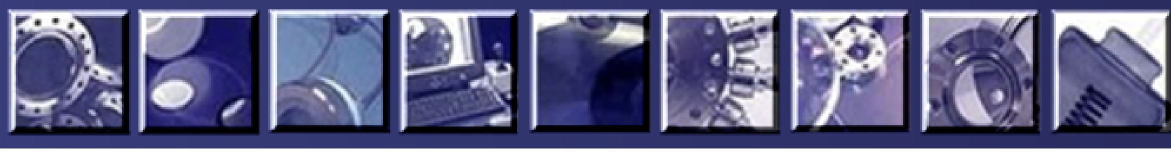


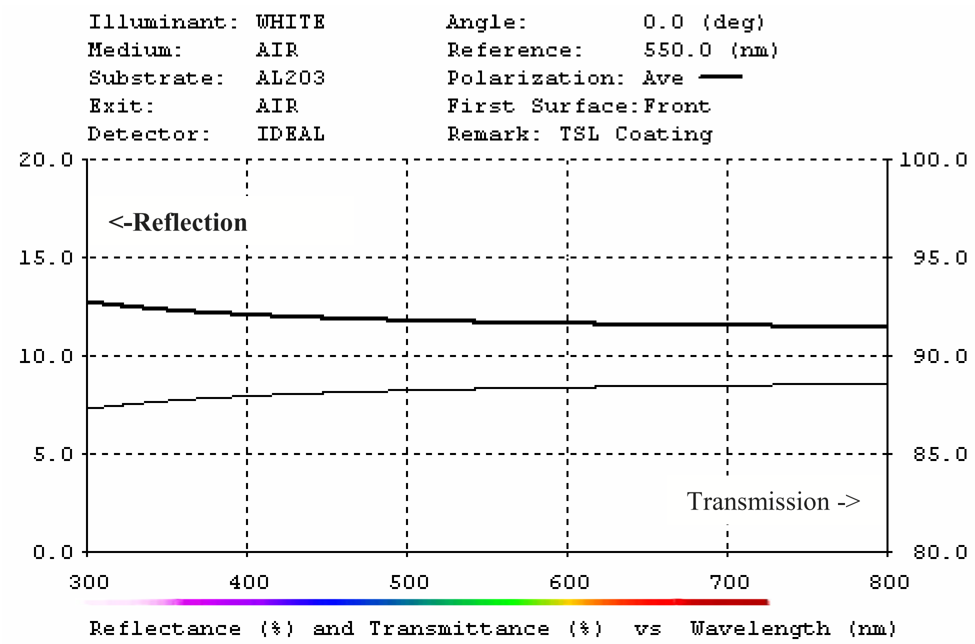
HIGH PERFORMANCE COATINGS FOR UHV CONFLAT VIEWPORTS

Transmission & Anti-Reflection Coatings

All windows and viewports suffer Fresnel reflectivity losses

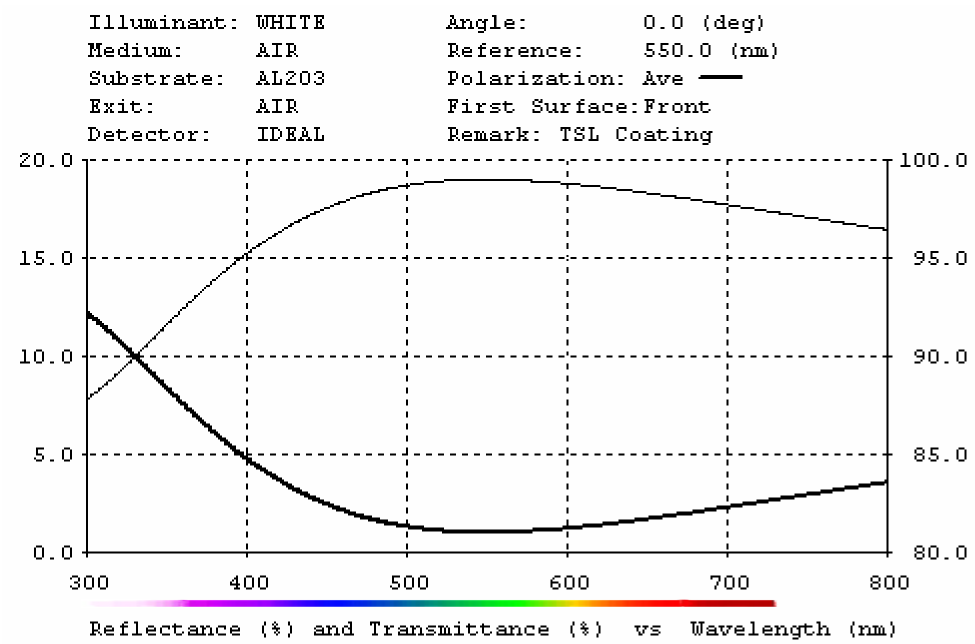
Reflectivity $r = [(n-1)/(n+1)]^2$ (where n is the refractive index)

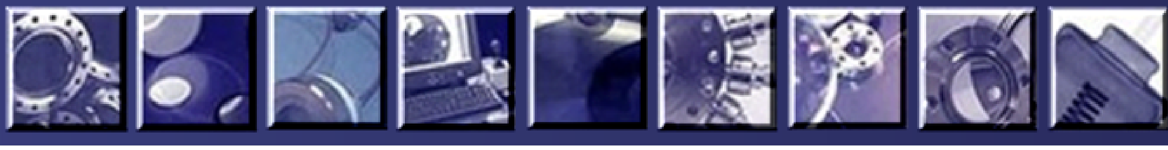
which can be on the order of 6% per face for high refractive index windows such as Sapphire. The reflection is different for p and s polarised waves, and is a function of angle.



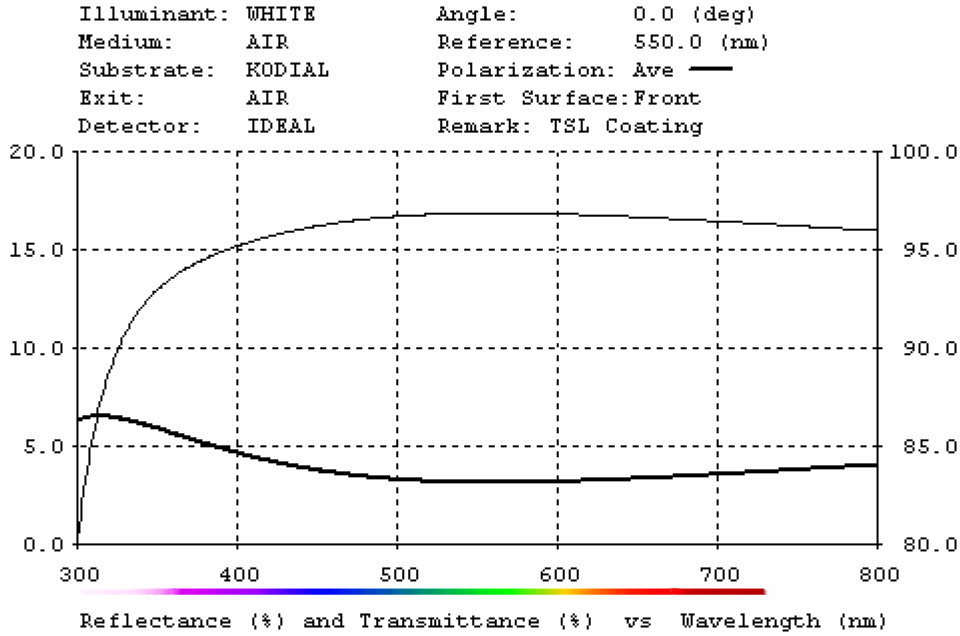
This problem can be a severe limitation in many applications requiring optical fidelity, viewing of low luminosity against a high ambient, power transmission etc.

However the problem can be mitigated using anti-reflection coatings. In the case of Sapphire, due to a fortuitous relationship between the refractive indices, a considerable improvement can be obtained using a simple single QWOT (Quarter Wave Optical Thickness) of MgF_2 as shown below.





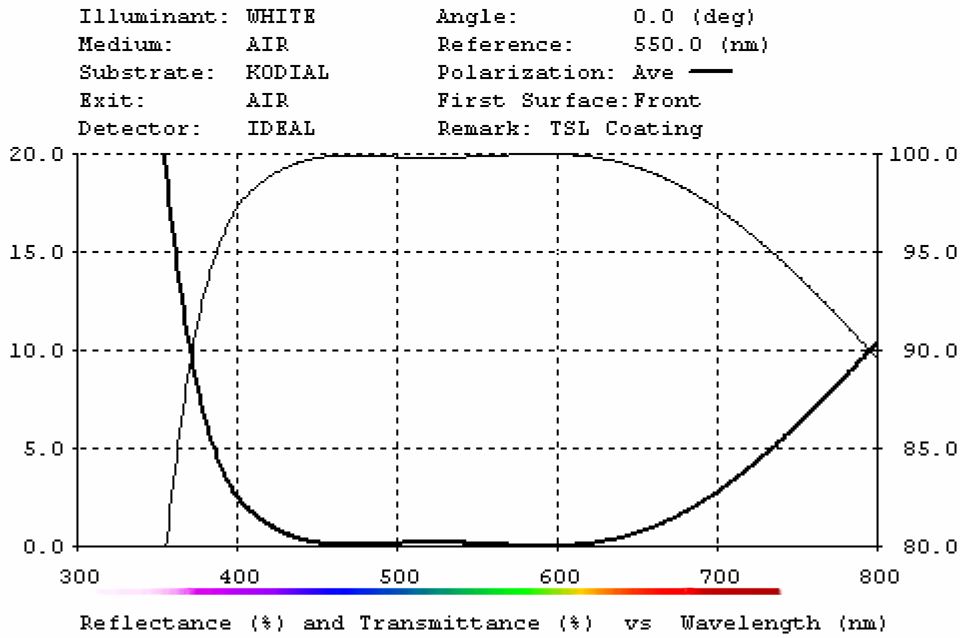
For more conventional viewport materials such as Kodial and fused quartz this simple approach would provide less obvious, but still useful benefit.



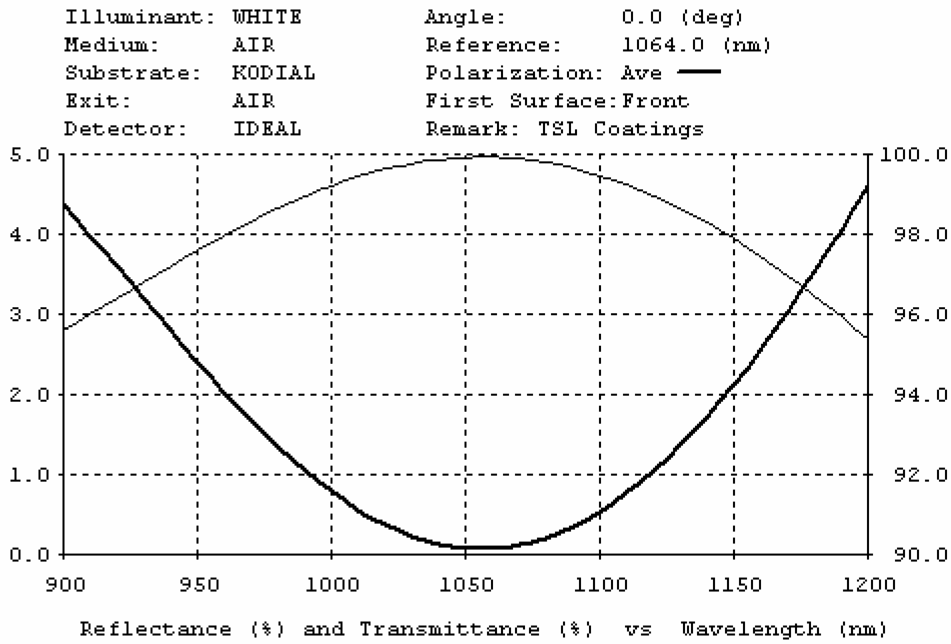
More complex multi-layer dielectric coatings enable a wide variety of tailored transmission / reflection characteristics giving for example virtually zero reflection at a single design wavelength ('V' coating) or at two wavelengths ('W' coating), or over a wide band BBAR or a neutral density attenuation, and many others.

Below is a selection of illustrative examples of coatings TSL can provide on Kodial, Fused Quartz, and Sapphire viewports.

A Broad Band Coating – optimised typically but not exclusively for the visible range and giving the best general performance, with a theoretical reflected luminosity of only 0.13% and transmitted luminosity of 99.86%



For applications requiring the best transmission at a single wavelength, such as high power laser applications, TSL can provide a 'V' Coating having just about zero reflection at a design wavelength 1064 nm for example.

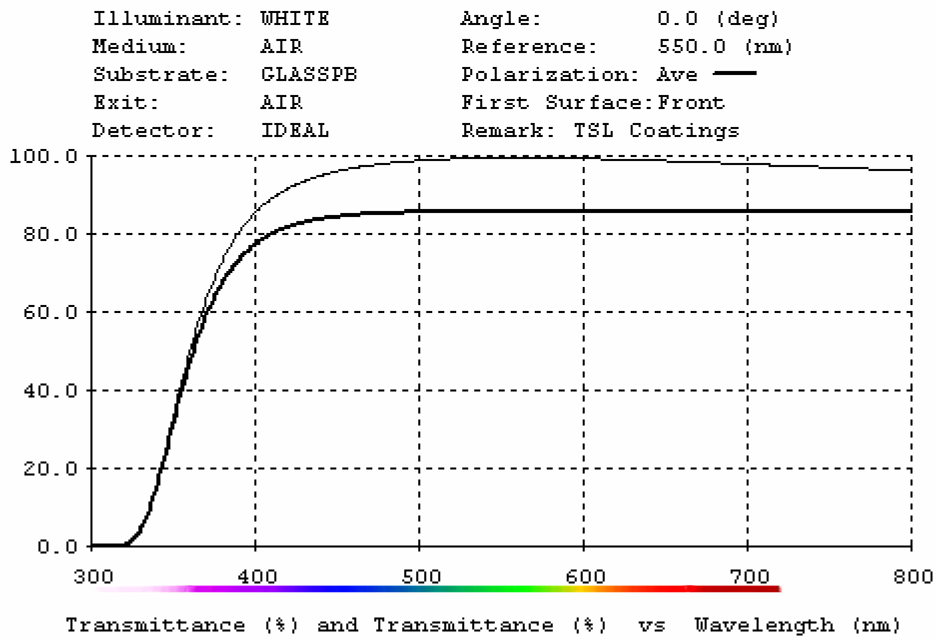


TSL can also provide more exotic coated viewports such as MgF_2, CaF_2, ZnSe, with coatings to provide optimum transmission in the Infrared and Ultra-violet.

X-Ray Shielding

Lead Glass windows are often used in conjunction with vacuum viewports to reduce the leakage of ionising radiation. However the high lead content gives the glass a high refractive index, and therefore high reflectivity also.

Again the application of an AR coating can considerably improve the visibility of lead glass windows. The figure below shows the typical transmission of lead glass (not including internal absorption) before (bold line) and after the application of a simple AR coating.

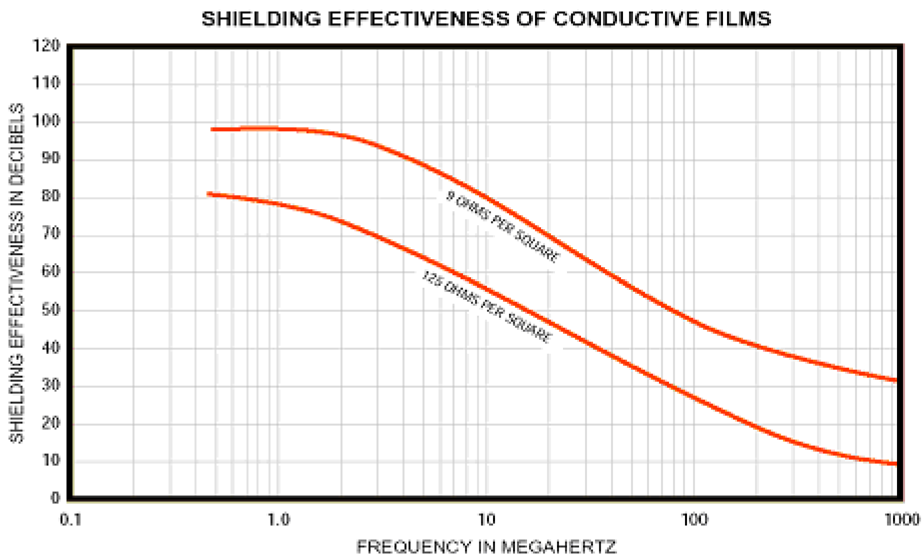


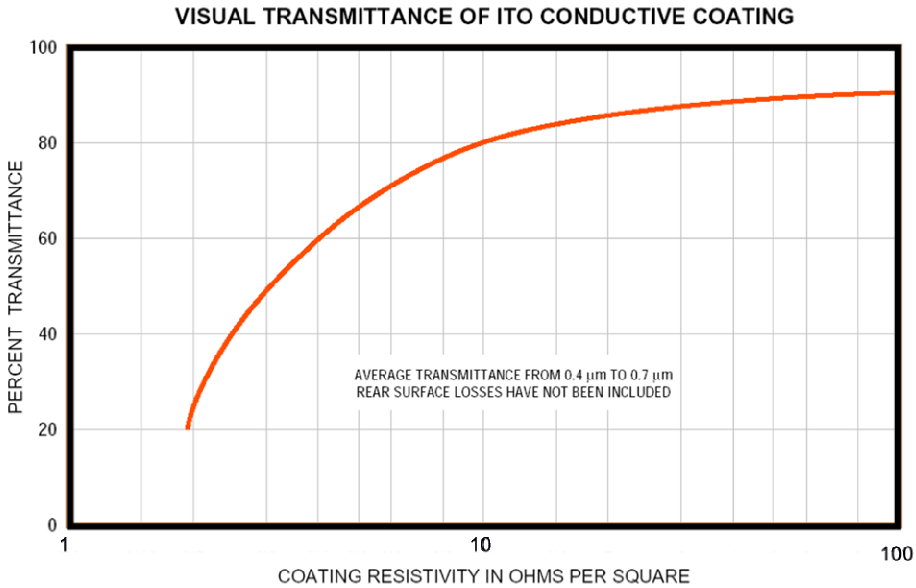
Conductive Coatings

Torr Scientific also coat viewports with transparent conductive coatings such as ITO (Indium Tin Oxide) to provide surface conductivity either to eliminate electrostatic charge build up, or to improve EMC / RFI screening.

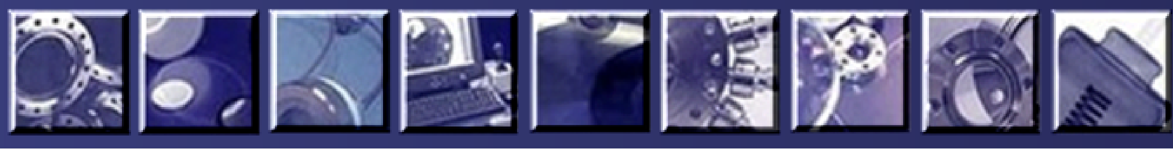
For electrostatic problems a thin ITO coating giving ~ 1kΩ / sq, and optimum optical transmission is usually employed.

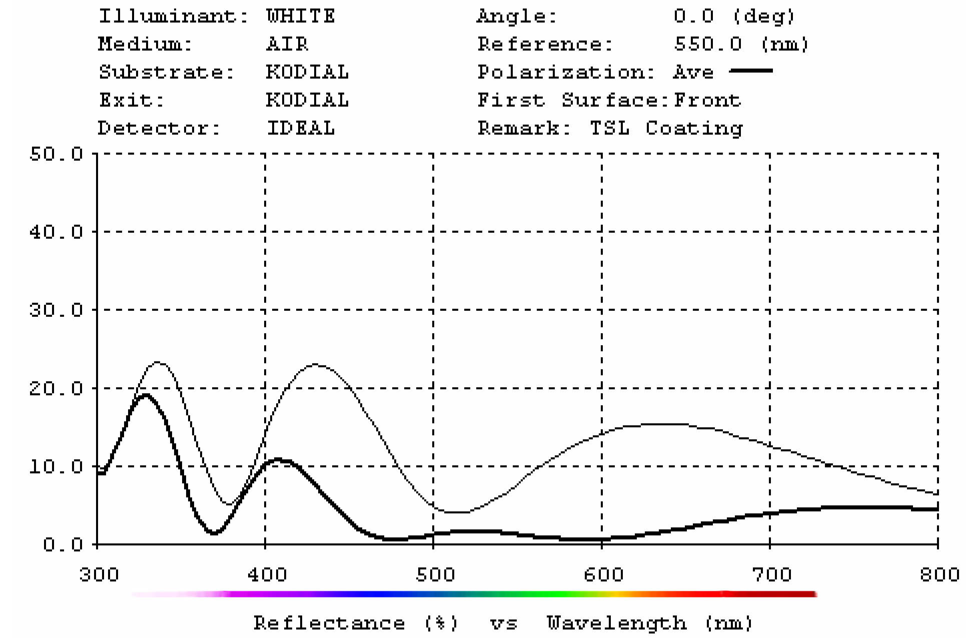
For screening problems thicker more conductive coatings are used giving typically ~10 Ω / sq.



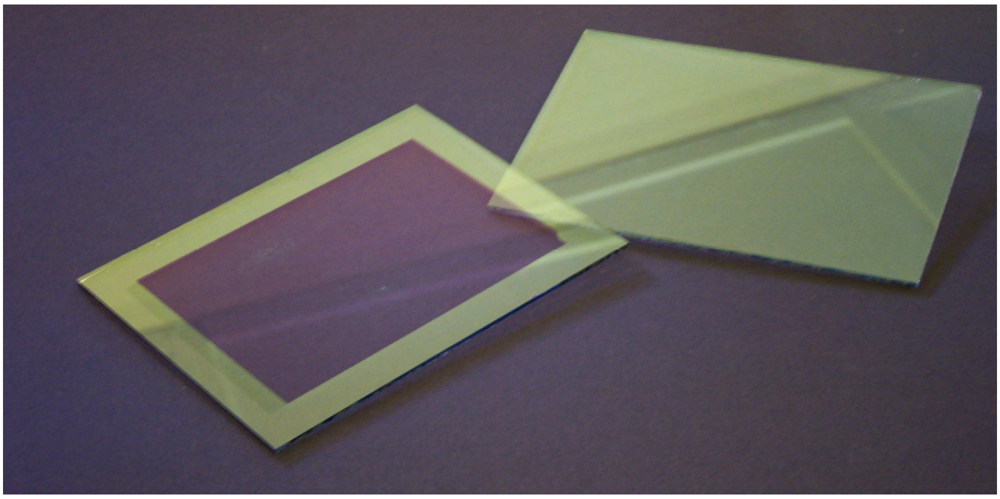


As ITO has a high refractive index, the coated window will also have higher reflectivity after coating with ITO. For this reason TSL can also provide an AR overcoat which will reduce reflections. The figure below shows the front surface reflection form ITO coated glass before and after the application of a simple AR overcoat.





Obviously this is not applicable where electrostatic screening against charge build up is required, but where EMC / RFI is the issue the improvement in optical performance is quite striking as illustrated in the photograph below. This shows a sheet of ITO coated glass viewed at an angle where the surface reflection is most visible, beside a similar sheet where the central section has been AR coated leaving a frame around the outside to make electrical connection.



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