Pros and Cons of Surface (Hard) and Protected (Soft) Coatings

Most contemporary optical coatings are made of refractory oxides of certain metals. Typically, Al, Si, Ti, Ta, Hf, Nb, and other oxides are deposited by either an evaporation process or a sputtering process. With evaporation, an ancillary or primary beam of energetic ions is directed at the condensing surface to provide adequate energy to achieve a dense film. These films are often referred to as hard.

In addition to oxide materials, there are numerous inorganic compounds. These compounds are typically more easily evaporated and tend to condense in more regular films with much lower energies associated with the process. Therefore, factors such as ideal refractive index, uniform stoichiometry, uniform distribution, and film design complexity can be enhanced. These films are typically softer than the substrate to which they are deposited and thus are protected with a cover window. RSS categorizes these as protected coatings, and the industry refers to them as soft coatings.

The performance impact of a protected coating is that the protective window will have a Fresnel reflection unless coated with an anti-reflective ("AR") coating. This does result in a 3.5% loss in throughput or a very slight increase in acquisition time. Offsetting this is the critical feature that the performance is highly consistent. A scratch of a few micrometers in width on a hard coating can easily reduce the S/N by an order of magnitude.

The primary benefit with these lower energy deposition processes is cost, with a factor of 10 easily achievable. Where a deposition of a surface coating can easily run into the tens of thousands of dollars, a protected coating can be well under a thousand dollars.

The protected coatings are optically contacted to their surface window with an optical bonding epoxy or silicone compound. Over long exposure and especially in moisture saturated environments water can be absorbed into the bonding agent, resulting in minor loss of throughput. A very serious case of moisture caused haze in an interference filter typically results in a 10% loss of throughput.

The refractory oxides tend to match well with the visible, near UV and NIR. As one extends into the UV or FIR, the refractive index options of the more open pallet of compounds of semiconductor materials opens viable options. This is especially true in the Mid to Far IR. The oxides all go into absorption at wavelengths in the mid IR.