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Editorial

Special issue on optical coatings

What exactly is an optical coating? Virtually, any surface that interacts in some way with light, in its broadest sense, can benefit from a treatment that improves its relevant properties. Such a treatment is what we describe as an optical coating. Usually, there is a presumption that the treatment should be an engineered one, but we must admit that nature was first by a long way in the employment of coatings.

It is difficult today to imagine any optical system where performance could not be improved by suitably designed optical coatings. Even the humble glass window can now exercise a high degree of thermal control on our buildings, thanks to specially designed optical coatings. Incandescent floodlights that illuminate our buildings use much less electrical power than previously, thanks to coatings that transmit the visible light but reflect the heat back to their filaments. Spectacle wearers benefit from the reduction in glare and the suppression of certain harmful optical rays assured by the optical coatings on their lenses. There are many more examples that affect us in our daily lives.

In any optical system, the surfaces that manipulate the light can be worked to a given shape and smoothness with an incredible degree of accuracy, but their specular properties, determined by the material forming their surfaces, are seldom, if ever, ideal. Frequently, without modification, they would even prevent the proper functioning of the system. Correction is achieved by the application of optical coatings. The optical performance of a coating is most often assured by interference effects combined with the optical properties of materials in thin film form that constitute it. Although coatings commonly involve the addition of thin film material, included in the class of optical coatings are treatments that modify the structure of the surface itself, usually by selective removal of material.

In the simplest cases, reflectance and transmittance and their spectral variation are the parameters requiring adjustment, but much more may be necessary. Phase and polarizing properties can be of major importance. A requirement to reflect an ultrafast pulse may include the simultaneous improvement of its shape. Light in different spectral regions may require separation. An exciting spectral line may have to be removed from a weak signal it has produced. Color may be critical. Optical communication channels may have to be combined, or multiplexed, or perhaps separated, or demultiplexed. A coating may be required to conduct electricity as well as transmit light, apparently conflicting requirements.

Optical needs are difficult enough to satisfy, but there are all kinds of additional requirements that are not strictly optical. The nature of an optical coating is that it is always on the surface of a component where it can be and, usually is, called upon to afford a degree of environmental protection to sensitive underlying material. The ultimate environmental resistance of an optical component frequently depends totally on its applied optical coatings.

Of course, perfection is an elusive state, and coatings, as with all other components, do not completely achieve it, although the performance gap may be vanishingly small. Scattering of light into undesired directions is a performance defect that is receiving a great deal of attention. There are others.

So far, we have described coatings largely as an enabling technology where, although they assure performance, the objective of the coatings can be separated from that of the system. However, there are many applications where the properties of the thin films, themselves, are central and where the objectives of both coating and system coincide. For example, many sensors of different kinds are based on optical coatings.

The earliest deliberately engineered optical coatings are lost in prehistory, but almost certainly, they were thin metallic layers that enhanced the reflectance of mirrors. Thin dielectric films and their properties were well known by the time of Newton, but as a curiosity rather than something useful, and it was not until the third decade of the 20th century when the complexity of optical systems reached the stage where dielectric coatings assumed critical importance. Nowadays, coatings of all kinds are so well established that they are largely taken for granted. But this should not be interpreted as an indication that the subject has in any way become static. Although after some 80 years of intensive development we may be forgiven for describing the field of optical coatings as mature, it remains as active as optics itself. In its more common role, it responds to the needs of optics, which are constantly developing. The X-ray region, for example, is now properly part of what we call optics and with that comes the

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need for coatings. A range of incredibly sensitive detectors of biochemical processes is being based on optical coatings. Yet, another example is afforded by the constantly decreasing length of optical pulses that is bringing broader dispersive requirements to the coatings that reflect them.

The present collection of papers is a small selection from what is a continuously expanding and developing subject. The editors hope that they will convey the excitement, interest, enthusiasm, and drive of the optical coating community that is constantly innovating and responding to new, often formidable, challenges. Without optical coatings, where would modern optics be?

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