Theory of the Spectral Transmittance of Christiansen Filters

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Abstract

Christiansen filters are usually made of grains of transparent materials, such as glass, immersed in an index–matching fluid. If the index of the grains matches that of the fluid the spectral transmittance is maximum. It decreases with increasing difference between the refractive indices. Since a formula due to Raman and Shelyubskii, which is widely used in the literature to describe the spectral transmittance of such filters, has no scientific basis, a new theory is developed taking into account reflection and refraction at the boundaries between grains and fluid. The theory is applied to spheres distributed in the immersion fluid. In this case, adjustable parameters are not required. For grains of arbitrary shape an adjustable parameter is introduced. The theory takes into account the aperture angles of the incident beam and of the detector to measure the transmittance. It predicts the dependence of the spectral transmittance as a function of the difference between the refractive indices, the average grain diameters and the thickness of the filter. The inhomo-geneity of the glass grains can also be taken into account. The spectral transmittance curves published in the literature are qualitatively quite well described. Exact fits, however, are not possible, since the aperture angles are generally not given for the published results. Therefore, experimental investigations controlling all necessary parameters are in progress.