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The reflection cross section of a glass sphere in a dielectric medium

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Abstract

The reflection cross section has been calculated numerically for a plane incoherent electromagnetic wave incident on a dielectric sphere in a dielectric as a function of the relative difference of the refractive indices of both media. The radius of the sphere is assumed to be very large compared with the wavelength and the coherence length so that interference and diffractive effects can be neglected. Both materials are assumed to be homogeneous and isotropic. With the refractive indices n_1 and n_2 of the surrounding medium and the sphere, respectively, both cases $n_1 > n_2$ and $n_2 > n_1$ have been considered. The dominant contributions arise from reflectance into the forward direction if $|\Delta n| << 1$. The numerical calculations show that the total reflection losses are proportional to the relative difference $|\Delta n|$ of the refractive indices of both media over quite a large interval on a logarithmic scale. If $n_1 > n_2$, total reflection increases the reflection cross section by a factor of about four, as compared with the case $n_2 > n_1$. For very large $|\Delta n|$, however, this difference decreases and the reflection cross section approaches the geometric cross section of the sphere in both cases, i.e. nearly all radiation incident on the sphere experiences reflection, as can be expected. In experimental investigations, the relative reflection cross section becomes smaller and proportional to $|\Delta n|^2$ in the range of small $|\Delta n|$ due to the aperture of the detector. The transition occurs if the angular range with large reflectance depending on $\sqrt{|\Delta n|}$ coincides with about one forth of the full aperture angle.

The results can be applied to the transmittance of dielectric spheres in a dielectric such as foam or other disperse systems.