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Refractive Index and Its Applications

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The refractive index or index of refraction (n_D) is one of the physicochemical properties of substances (optical medium). It is equal to velocity (c) of light of a given wavelength in empty space (vacuum) divided by its velocity (v) in a substance according to following equation:

$$n_D = \frac{c}{\upsilon} \quad (1)$$

When light travels at an angle between two materials, it bends according to their refractive indices. In order to reflect, light must be on the wider side of the critical angle.

The refractive index can provide information for us about the behavior of light. When light passes through the different substances its velocity decreases by increasing of the refractive index of these substances. It can be due to interaction between molecules of components in substrate and effect of these interactions on light. Also in the most substrates, the refractive index decreases by increasing of the temperature. The interaction between molecules decreases as the temperature increases.

The refractive index of different substrates measures with refractometers. There are four main types of refractometers: traditional handheld refractometers, digital handheld refractometers, laboratory or Abbe refractometers, and inline process refractometers. There is also the Rayleigh Refractometer used (typically) for measuring the refractive indices of gases.A sodium lamp may be used to provide the light source at a known wave-length (589.6 nm) although many instruments are corrected for daylight use.

In most of substrates which we know the refractive index have a positive value (more than zero) but in 1968 Veselago shows that there are substrates with negative permittivity and negative permeability. In these substrates refractive index have a negative value.

Maxwell's equations relate the permittivity and the permeability to the refractive index as follows:

$$n = \pm\sqrt{\varepsilon\mu} \quad (2)$$

The sign of the index is often taken as positive. However, Veselago showed that if a substrate has both negative permeability and negative permittivity, this convention must be reversed and we must pick out the *negative* sign of the square root.

Refractive index has the large number of applications. It is mostly applied for identify a particular substance, confirm its purity, or measure its concentration. Generally it is used to measure the concentration of a solute in an aqueous solution. For a solution of sugar, the refractive index can be used to determine the sugar content (Brix degree). It can be used also in determination of drug concentration in pharmaceutical industry.

It is used to calculate the focusing power of lenses, and the dispersive power of prisms. Also it is applied for estimation of thermophysical properties of hydrocarbons and petroleum mixtures.

As can be seen in the above rows, the study on refractive index of substrates can be useful in various fields (both industry and academic).

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