

Index of Refraction

Key Words:

- Refractive Index
- Real Component
- Imaginary Component
- Cauchy Dispersion Formula

INTRODUCTION

Our strength is in offering you a complete particle technology. We give you simple protocols for working with particles. We provide you concrete data, backed by years of applications research in our own labs.

The index of refraction (or refractive index) of a material is the ratio of the speed of light in a vacuum to the speed of light through a given material. For materials that absorb light, the refractive index is expressed as a complex number:

$$n_c = n_r - n_i i$$

where n_c is the complete index of refraction of a material, n_r is the real component, and n_i is the imaginary component. The real component of the complex number is called the absolute index

of refraction and is always greater than 1 (since the speed of light is fastest in a vacuum).

The imaginary component is related to the light absorption properties of the bulk material. For our NIST traceable standard products, including polystyrene and glass, the imaginary component is negligible in the visible wavelengths. Here is a list of the real components of the indices of refraction for some of our products.

| | | |
|---------------------------------|-------------|-------------------------|
| Polystyrene Microspheres | 1.59 | @ 589 nanometers (23°C) |
| Silica Microspheres | 1.40 - 1.46 | @ 589 nanometers (23°C) |
| Borosilicate Glass Microspheres | 1.56 | @ 589 nanometers (23°C) |
| Soda Lime Glass Microspheres | 1.51 - 1.52 | @ 589 nanometers (23°C) |

The Cauchy dispersion formula gives an empirical relationship between the index of refraction and the wavelength of light:

$$n = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4}$$

where λ is the wavelength of light expressed in microns. The constants A, B, and C are determined experimentally. The following table shows the values of these constants as measured from bulk polystyrene and from our polystyrene particles.

The values in the table can be helpful if you need to estimate the index of refraction of our polystyrene particles at an excitation wavelength far away from 589 nm. However, these two sets of data do not agree perfectly and it is almost always adequate

| Constants | Bulk Polystyrene Values ¹ (Valid between 435—768nm Wavelengths) | Polystyrene Microsphere Values ² (Valid between 390—1310nm Wavelengths) |
|-----------|---|---|
| A | 1.5663 | 1.5725 |
| B | 0.00785 | 0.0031080 |
| C | 0.000334 | 0.00034779 |

to use 1.59 for the index of refraction. Please refer to the original papers for details about how these values were determined. Papers are listed on page 2.

If you have any further questions regarding the index of refraction of any Thermo Scientific microspheres, please contact our technical service department at

info.microparticles@thermofisher.com.

Footnotes

1 Boundy, Ray H., and Boyer, Raymond F., ed. Styrene. Its Polymers, Copolymers and Derivatives., Reinhold Publishing Corp., NY. 1952 pp. 523-525.

2 Ma X, Lu J Q, Brock R S, Jacobs K M, Yang P and Hu X H. 2003. Determination of complex refractive index of polystyrene microspheres from 370 to 1610 nm. Physics in Medicine and Biology 48 4165-4172.

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