

National Bureau of Standards

Certificate

Standard Reference Material 2211

Toluene

This Standard Reference Material (SRM) is intended primarily for use as a density and a refractive index standard. SRM 2211 consists of 8 mL of commercially obtained toluene in a special "breakseal" ampoule.

DENSITY

The density of this material was measured with a picnometer of special design having a volume of 108 mL. During the measurements, the temperature of the bath was maintained constant to ± 0.01 °C.

The certified densities given in Table 1 are based on weights in vacuum, with the sample at a pressure of 1 atmosphere and saturated with air.

Table 1

Temperature, °C	Density, g/cm ³
20.00	0.86686
25.00	0.86222
30.00	0.85761

The uncertainties in the density values are ± 0.00002 g/cm³.

The density of air-free material is greater than that of air-saturated material by about 0.01 percent. Near 1 atmosphere, the change of density with pressure is of the order of 0.01 percent per atmosphere. The method and apparatus used for certification are described in the following publications: NBS Technological Paper No. 77 (1916); Bulletin NBS 9, 405 (1913).

(over)

REFRACTIVE INDEX

The refractive index of SRM 2211 was determined at seven wavelengths and at temperatures near 20, 25, and 30 °C. Measurements were made on a precision spectrometer using the minimum-deviation method. The toluene was contained in a water-jacketed prismatic cell mounted on the spectrometer table. A temperature controlled water bath maintained nearly constant temperature of the samples. Spectral lamps of mercury, cadmium, and helium were used for wavelength sources. The temperature coefficient, $\Delta n / \Delta T$, was determined at each wavelength for all samples, and an average value of $\Delta n / \Delta T$ was used to determine the refractive index for that wavelength at 20, 25, and 30 °C.

The air temperature of the laboratory was maintained near 20 °C during all measurements. The certified values of refractive index, referenced to air at 20 °C for the three temperatures, are listed in Table 2. The refractive index values are considered to be accurate within $\pm 1 \times 10^{-4}$ at 20 °C, $\pm 2 \times 10^{-4}$ at 25 °C, and $\pm 4 \times 10^{-4}$ at 30 °C. The refractive index value given for each wavelength at each temperature is an average of the values determined for the four samples at that wavelength and temperature. These average values are considered to be representative of the refractive indices of this batch of toluene.

Table 2

Wavelength (nm)	Spectral Source	Refractive Index		
		20.0 °C	25.0 °C	30.0 °C
435.83	Mercury,g	1.5180	1.5148	1.5116
479.99	Cadmium,F'	1.5094	1.5063	1.5032
508.58	Cadmium	1.5052	1.5021	1.4991
546.07	Mercury,e	1.5008	1.4978	1.4947
587.56	Helium,d	1.4970	1.4940	1.4910
643.84	Cadmium,C'	1.4931	1.4901	1.4871
667.81	Helium	1.4918	1.4888	1.4858

The density measurements were made by W.H. Gallagher of the Automated Production Technology Division, NBS Center for Manufacturing Engineering.

The refractive index measurements were performed by M. Dodge of the Semiconductor Materials and Processes Division, NBS Center for Electronics and Electrical Engineering.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by R.W. Seward.

Gaithersburg, MD 20899
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