NIST Traceableについて

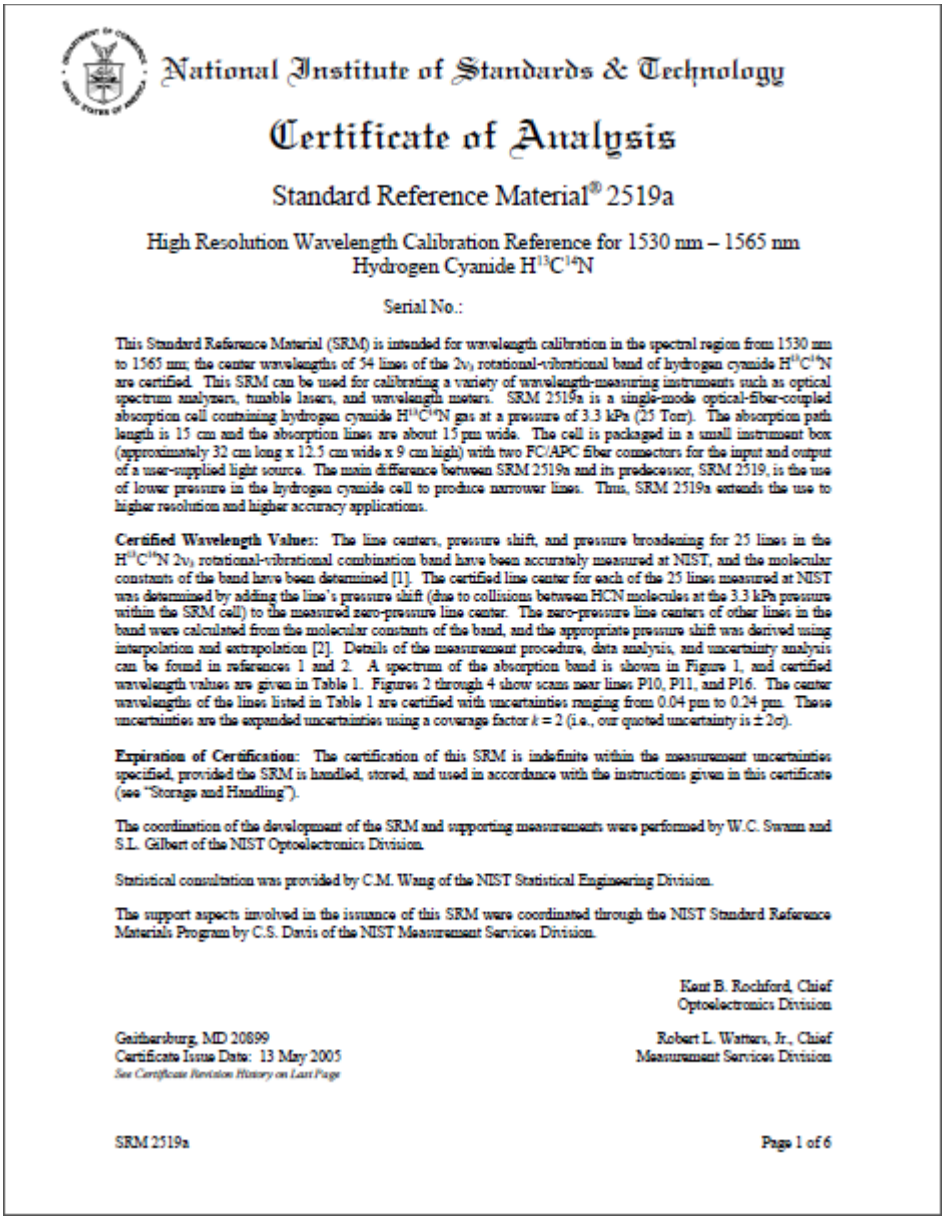
Smart Sensing Solutions

cmiws

NIST(National Institute of Standards and Technology)

アメリカ合衆国の技術、産業、工業などに関する規格の標準化を行っている政府機関です。
日本におけるJISがこれにあたります。

NISTの役割の1つとして認証している標準試料(Standard Reference Material, SRM) があります。
下図はその1つであるSRM2519a のシアン化水素(Hydrogen Cyanide, HCN)の波長を利用した測定機器の校正についての認証です。Micron Optics社製光計測器のガスセル内臓による波長校正はこの認証に基づいています。



National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material® 2519a

High Resolution Wavelength Calibration Reference for 1530 nm – 1565 nm
Hydrogen Cyanide $H^{13}C^{14}N$

Serial No.:

This Standard Reference Material (SRM) is intended for wavelength calibration in the spectral region from 1530 nm to 1565 nm; the center wavelengths of 54 lines of the $2\nu_3$ rotational-vibrational band of hydrogen cyanide $H^{13}C^{14}N$ are certified. This SRM can be used for calibrating a variety of wavelength-measuring instruments such as optical spectrum analyzers, tunable lasers, and wavelength meters. SRM 2519a is a single-mode optical-fiber-coupled absorption cell containing hydrogen cyanide $H^{13}C^{14}N$ gas at a pressure of 3.3 kPa (25 Torr). The absorption path length is 15 cm and the absorption lines are about 15 pm wide. The cell is packaged in a small instrument box (approximately 32 cm long x 12.5 cm wide x 9 cm high) with two FC/APC fiber connectors for the input and output of a user-supplied light source. The main difference between SRM 2519a and its predecessor, SRM 2519, is the use of lower pressure in the hydrogen cyanide cell to produce narrower lines. Thus, SRM 2519a extends the use to higher resolution and higher accuracy applications.

Certified Wavelength Values: The line centers, pressure shift, and pressure broadening for 25 lines in the $H^{13}C^{14}N$ $2\nu_3$ rotational-vibrational combination band have been accurately measured at NIST, and the molecular constants of the band have been determined [1]. The certified line center for each of the 25 lines measured at NIST was determined by adding the line's pressure shift (due to collisions between HCN molecules at the 3.3 kPa pressure within the SRM cell) to the measured zero-pressure line center. The zero-pressure line centers of other lines in the band were calculated from the molecular constants of the band, and the appropriate pressure shift was derived using interpolation and extrapolation [2]. Details of the measurement procedure, data analysis, and uncertainty analysis can be found in references 1 and 2. A spectrum of the absorption band is shown in Figure 1, and certified wavelength values are given in Table 1. Figures 2 through 4 show scans near lines P10, P11, and P16. The center wavelengths of the lines listed in Table 1 are certified with uncertainties ranging from 0.04 pm to 0.24 pm. These uncertainties are the expanded uncertainties using a coverage factor $k = 2$ (i.e., our quoted uncertainty is $\pm 2\sigma$).

Expiration of Certification: The certification of this SRM is indefinite within the measurement uncertainties specified, provided the SRM is handled, stored, and used in accordance with the instructions given in this certificate (see "Storage and Handling").

The coordination of the development of the SRM and supporting measurements were performed by W.C. Swann and S.L. Gilbert of the NIST Optoelectronics Division.

Statistical consultation was provided by C.M. Wang of the NIST Statistical Engineering Division.

The support aspects involved in the issuance of this SRM were coordinated through the NIST Standard Reference Materials Program by C.S. Davis of the NIST Measurement Services Division.

Kent B. Rochford, Chief
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Certificate Issue Date: 13 May 2005
See Certificate Revision History on Last Page

Robert L. Watters, Jr., Chief
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ガスセル

分子ガスはエネルギーレベルの遷移に応じた吸収線スペクトルを持っており、環境条件に左右されません。この特性を利用して光源の波長の校正を行うことが可能です。
分子ガス基準セルは近赤外線領域に多くの吸収線があるため通信用測定器や光源の校正用光源として利用されています。
NISTは標準試料(SRM)として、2515のCO(一酸化炭素) や2519のHCN(シアン化水素) 等に基づいて波長基準を規定しています。

$H^{13}C^{14}N$ガスセル

分子吸収線は温度や圧力の変化、時間の経過に対して非常に安定しています。
下図のように1530 nmから1565 nmの 領域で50本以上の吸収線が得られます。

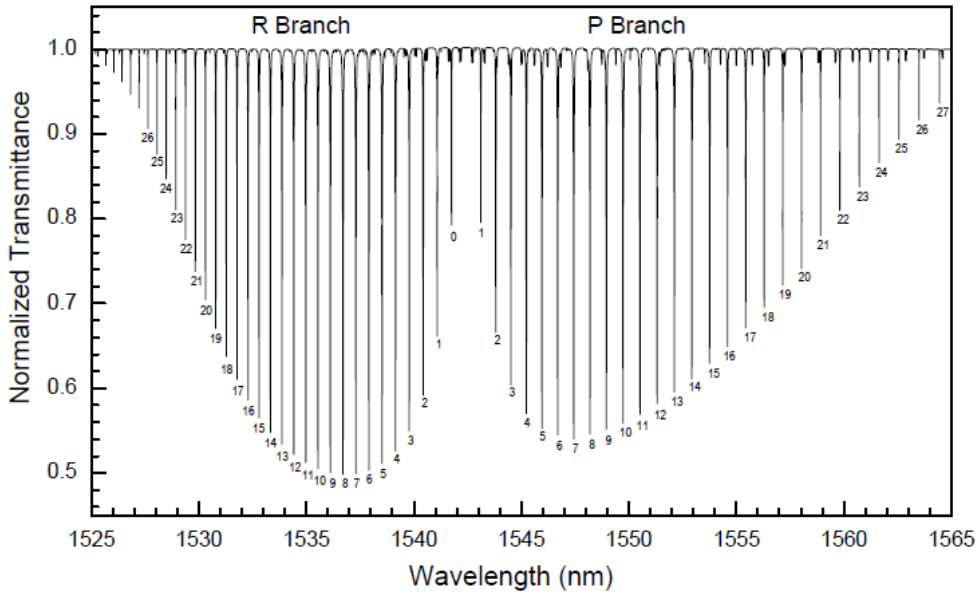

Figure 1. Spectrum of the hydrogen cyanide $H^{13}C^{14}N$ $2\nu_3$ rotational-vibrational band obtained by scanning a tunable diode laser and measuring the laser power transmitted through a 15 cm long absorption cell filled to a pressure of 3.3 kPa (25 Torr).

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ガスセルは環境条件の影響を受けない一例として、気圧の変化時(3.3±0.7 kPa)におけるHCNガスの影響についての結果が以下の表です。

Table 1. Pressure Shift of $H^{13}C^{14}N$ Lines: Pressure shift coefficients and pressure shifts at SRM 2519a pressure of 3.3 ± 0.7 kPa for lines in the $2\nu_3$ band of $H^{13}C^{14}N$. The lines measured at NIST [4] are indicated in bold. The other line values are interpolated and extrapolated from the measured values. The pressure shift uncertainty is the quadrature combination of the contribution from the pressure shift coefficient uncertainty and the contribution from the cell pressure uncertainty.

line	pressure shift coefficient pm/kPa	coefficient standard uncertainty (1σ) pm/kPa	pressure shift at 3.3 kPa pm	shift standard uncertainty (1σ) pm
R26	0.043	0.016	0.143	0.056
R25	0.048	0.013	0.161	0.046
R24	0.054	0.010	0.180	0.038
R23	**0.060**	**0.001**	**0.198**	**0.020**
R22	0.065	0.006	0.217	0.031
R21	**0.071**	**0.001**	**0.236**	**0.024**
R20	0.076	0.007	0.252	0.034
R19	0.080	0.007	0.268	0.035
R18	**0.085**	**0.001**	**0.284**	**0.029**
R17	0.085	0.006	0.284	0.035
R16	0.085	0.006	0.283	0.035
R15	**0.085**	**0.001**	**0.283**	**0.028**
R14	0.076	0.006	0.253	0.032
R13	0.067	0.006	0.223	0.030
R12	**0.058**	**0.001**	**0.193**	**0.019**
R11	0.042	0.006	0.140	0.025
R10	**0.026**	**0.001**	**0.088**	**0.009**
R9	**0.005**	**0.001**	**0.018**	**0.003**
R8	**-0.021**	**0.003**	**-0.069**	**0.012**
R7	**-0.034**	**0.003**	**-0.114**	**0.016**
R6	-0.058	0.017	-0.195	0.061
R5	**-0.083**	**0.001**	**-0.275**	**0.028**
R4	-0.097	0.008	-0.323	0.043
R3	**-0.111**	**0.001**	**-0.371**	**0.037**
R2	-0.102	0.008	-0.339	0.043
R1	**-0.092**	**0.001**	**-0.308**	**0.031**
R0	**-0.066**	**0.001**	**-0.222**	**0.022**
P1	**0.043**	**0.001**	**0.143**	**0.015**
P2	0.059	0.007	0.196	0.029
P3	0.075	0.007	0.249	0.033
P4	**0.091**	**0.001**	**0.303**	**0.030**
P5	**0.084**	**0.001**	**0.280**	**0.028**
P6	0.063	0.007	0.211	0.032
P7	0.043	0.007	0.142	0.027
P8	0.022	0.007	0.073	0.025
P9	**0.001**	**0.001**	**0.004**	**0.003**
P10	**-0.024**	**0.001**	**-0.080**	**0.008**
P11	**-0.050**	**0.001**	**-0.165**	**0.017**
P12	-0.071	0.009	-0.235	0.038
P13	-0.091	0.009	-0.305	0.043
P14	**-0.112**	**0.001**	**-0.375**	**0.038**
P15	-0.126	0.012	-0.419	0.058
P16	**-0.139**	**0.002**	**-0.463**	**0.047**
P17	**-0.146**	**0.001**	**-0.485**	**0.049**
P18	-0.147	0.015	-0.491	0.069
P19	-0.149	0.015	-0.498	0.070
P20	**-0.151**	**0.003**	**-0.504**	**0.051**
P21	-0.145	0.014	-0.484	0.068
P22	-0.139	0.014	-0.465	0.067
P23	**-0.134**	**0.001**	**-0.445**	**0.045**
P24	**-0.126**	**0.001**	**-0.419**	**0.042**
P25	-0.118	0.014	-0.393	0.061
P26	-0.110	0.021	-0.367	0.080
P27	-0.102	0.029	-0.341	0.102

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表の圧力3.3 kPa の変化というのは、高度において10mで1 hPaの変化なので約330 m程の変化にあたります。この高度変化に対して、例えばP11の吸収線(1550.51546 nmの波長)では気圧の変化により- 0.165 pm(= - 0.000165 nm) だけ変化します。これは波長に対して約0.000011 % の減少であり、無視できるレベルにあると言えます。

このようにガスセルは環境変化にほとんど影響されないといった大きなメリットがあり、測定の校正に利用されています。

Micron Optics社の機器だけでなく、他社様の機器も“NIST Traceable”としてこういった校正方法を採用しており、海外のユーザー様では計測器を選択する際の必須の条件ともされております。