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Datasheet

# Scientific Raman Spectrometer ATR3100

## Features

Ultra-high signal-to-noise ratio and sensitivity
Detector TEC cooled to -15°C
Ultra-low noise circuit
Powerful embedded software
Eliminates fluorescence background
Peak search and display
USB 2.0
Field version (touchscreen, lithium battery) optional
User-friendly human-machine interface

## Application

- Biological science
- Pharmaceutical engineering
- Forensic analysis
- Agriculture and food safety
- Gemstone
- Environmental science

## Description

The ATR3100 Portable Raman Spectrometer employs a cooled, high-sensitivity Raman signal-enhanced CCD, a high-efficiency Raman probe, and an ultra-narrow linewidth laser with a power output of up to 600mW. Combined with highly reliable optical, circuit, and structural design, it delivers extremely stable measurement results with an ultra-high signal-to-noise ratio, making it ideal for fieldwork. Its outstanding reliability ensures accurate and dependable detection results. Excellent low-stray-light conditions enable the spectrometer to be widely applied, particularly in biochemical analyzers, food safety, and pharmaceutical engineering. The versatile software facilitates the spectral analysis process in applications. Remote experiments via internet access make testing projects more convenient.

| Model | Description |
|---|---|
| ATR3100 | Standard Configuration |
| ATR3100TP | Built-in Android operating system, 6-inch touchscreen, lithium battery |




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# 1. Specifications

| ATR3100 Operating System (Taking the 785nm Model as an Example) | | | |
|---|---|---|---|
| Model | ATR3100 | ATR3100TP | |
| Interface | USB 2.0/LAN | USB 2.0 and WIFI | |
| Operating System | Computer operation | Android 6.0 | |
| Display | No | Capacitive touchscreen with multi-touch support | |
| Battery Power Time | No battery inside | Built-in lithium battery providing >5 hours of continuous operation | |
| Integration Time | 4ms - 120s | 4ms - 120s | |
| Voltage | DC 5V(+/-5%) | DC 5V(+/-5%) | |
| Operating Temperature | -25~50 ℃ | -25~50 ℃ | |
| Working Humidity | < 95% | < 95% | |
| Dimensions (L*W*H) | 340*165*240mm3 | 340*165*240mm3 | |
| weight | 5.1Kg | 6.1 Kg | |
| **Reliability** | | | |
| Spectral stability | σ/μ < 0.5% (COT 8 hours) | | |
| temperature stability | spectrum shift≤ 1 cm-1 (10-40 ℃) | | |
| Spectral intensity change (in 5 ~ 40 ℃) | <±5% | | |
| **Optical Parameters** | | | |
| Spectral range (cm-1) | 200-2600 | 200-3500 | 200-4300 |
| Resolution(cm-1) | 4-6 | 6-8 | 7-10 |
| signal-to-noise ratio | >3000:1 | | |
| **Detector** | | | |
| Model | Ultra-high sensitivity and rapid cooling CCD | | |
| Spectral range | 200-1100 nm | | |
| Effective Pixels | 2048*64 | | |
| **Excitation light** | | | |
| central wavelength | 785nm (±0.5nm) | | |
| half width | 0.08 nm | | |
| Output Power | ≥500 mW | | |
| Power stability | σ/μ <±0.2% | | |
| **Raman Probe** | | | |
| working distance | 6 mm | | |




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| | |
|---|---|
| Transmission rate | OD>8 |
| numerical aperture | 0.3 |
| Aperture | 7mm |

# 2. Optical Performance

According to the Chinese National Standard "General Specification for Raman Spectrometers," the resolution of the ATR3100DC was tested using the full width at half maximum (FWHM) of an elemental emission line peak as the Raman spectrometer's resolution. As shown in Figure 1, the results confirm that the resolution of the ATR3100DC can reach 4.5 $cm^{-1}$.

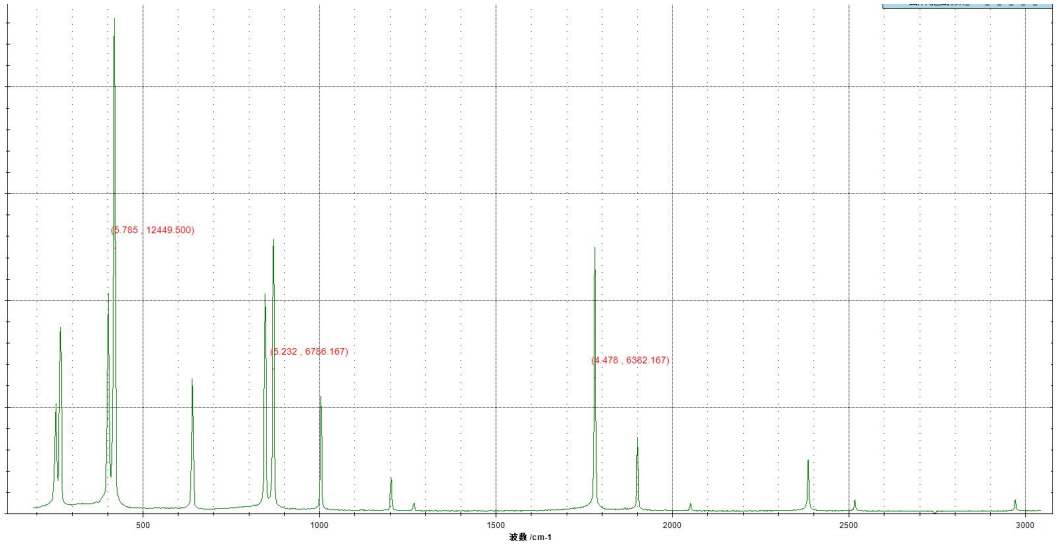


**Figure 1 Measured spectrum of ATR3100DC resolution**

The ATR3100 Raman spectrometer was used to analyze a synthetic diamond sample with the following parameters: excitation wavelength of 532 nm, wavenumber range of 200–3700 $cm^{-1}$, laser power of 100 mW, and integration time of 200 ms. The test results showed clear spectral features, including the characteristic diamond peak at 1332 $cm^{-1}$, the $NV^0$ center peak near 1420 $cm^{-1}$, and the $NV^-$ center peak near 3100 $cm^{-1}$.

The 1332 $cm^{-1}$ peak is a signature Raman signal of diamond, indicating the presence of a highly ordered diamond lattice in the sample. The intensity and shape of this peak provide further insights into crystal quality: a symmetric peak with no significant shift suggests low internal stress and minimal defects, whereas peak broadening or shifting may indicate lattice imperfections or impurities.

The $NV^0$ (1420 $cm^{-1}$) and $NV^-$ (3100 $cm^{-1}$) centers confirm the presence of nitrogen-vacancy (NV) defects in the sample. These defects form when nitrogen atoms substitute for carbon in the diamond lattice, creating adjacent vacancies. The NV centers exhibit unique optical and electronic properties, making them significant for various



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applications. In synthetic diamonds, the presence and distribution of NV centers are closely related to fabrication conditions, such as nitrogen doping concentration in CVD or HPHT processes and post-growth annealing. A strong NV signal may suggest higher nitrogen incorporation or insufficient thermal treatment, while the relative ratio of $NV^0$ to $NV^-$ can reflect process precision and consistency.

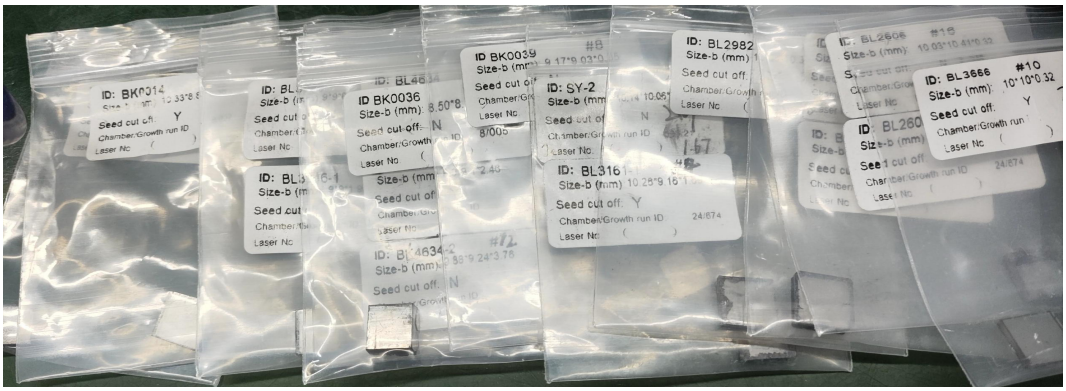


**Figure 2 Photograph of the synthetic diamond sample**

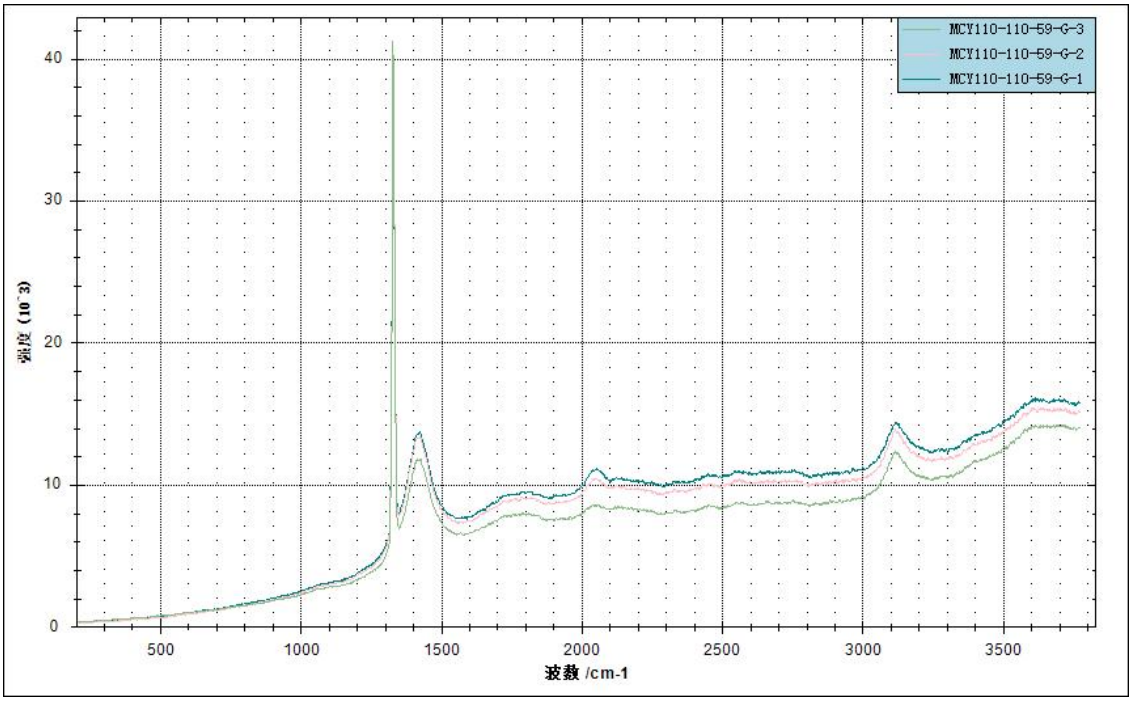


**Figure 3 Raman spectrum of synthetic diamond measured by ATR3100-532**

The ATR3100 analysis revealed that the diamond sample not only exhibits excellent crystalline quality (as verified by the 1332 $cm^{-1}$ peak) but also demonstrates specific defect states (NV centers). These findings provide critical insights for evaluating its potential applications (e.g., as quantum materials or optical devices) and for optimizing synthesis processes.

For the analysis of the gray plastic block, visible light excitation resulted in significant fluorescence background interference in the Raman spectra. Therefore, a 1064 nm laser was employed as the excitation source, with the following parameters: wavenumber range of




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200-2600 $cm^{-1}$, laser power of 150 mW, and integration time of 30 s. Thirty random points on the sample were measured, showing good consistency in the results without interference from sample autofluorescence.

**Figure 4 Photograph of the gray plastic block sample**

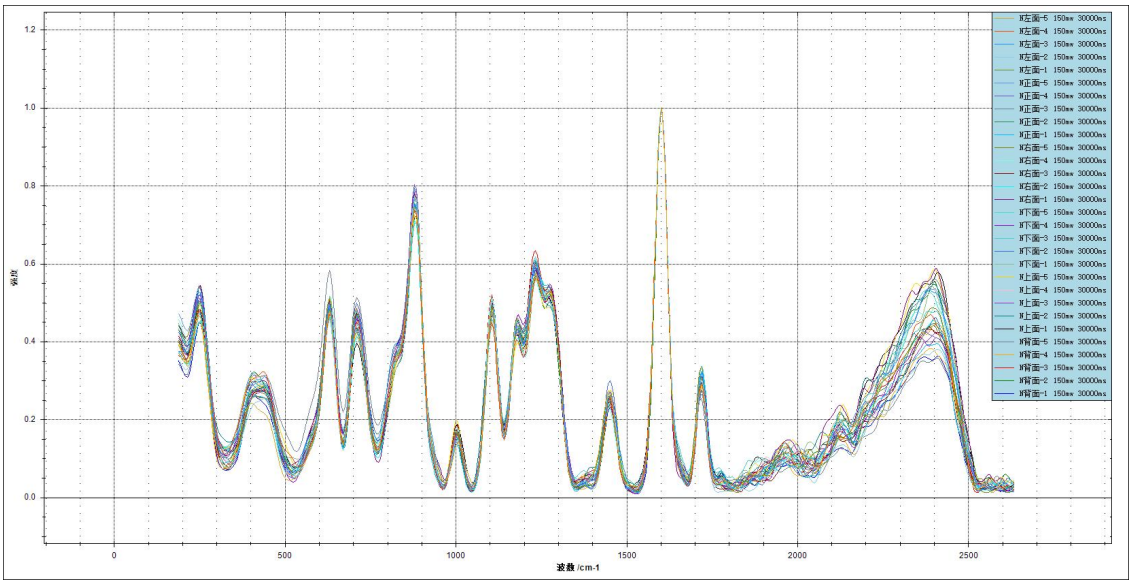


**Figure 5 Raman spectrum of the gray plastic block measured by ATR3100-1064**

The test results demonstrate that the ATR3100 possesses high-sensitivity detection capability, enabling clear identification of weak Raman signals while suppressing fluorescent background. Its excellent optical design and stable integration performance ensure no spectral shift or drift during repeated tests, making it suitable for consistency testing of industrial products.

The ATR3100 was used to analyze pork tissue with the following parameters: excitation wavelength of 785 nm, wavenumber range of 200–2700 $cm^{-1}$, laser power of 500 mW, and




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integration time of 60 s. Clear Raman characteristic peaks of pork tissue were observed near 1330, 1440, and 1650 $cm^{-1}$.

- 1330 $cm^{-1}$: Related to C-H deformation vibrations in proteins or specific vibrational modes of amino acids.
- 1440 $cm^{-1}$: Typically assigned to C-H bending vibrations in lipids, reflecting the fat content in pork.
- 1650 $cm^{-1}$: Characteristic C=C stretching vibration, mainly originating from the amide I band in proteins, closely associated with protein secondary structures (e.g., α-helix).

These peaks allow for the differentiation of protein and fat components in pork tissue, assessment of pork freshness, and analysis of potential adulteration.

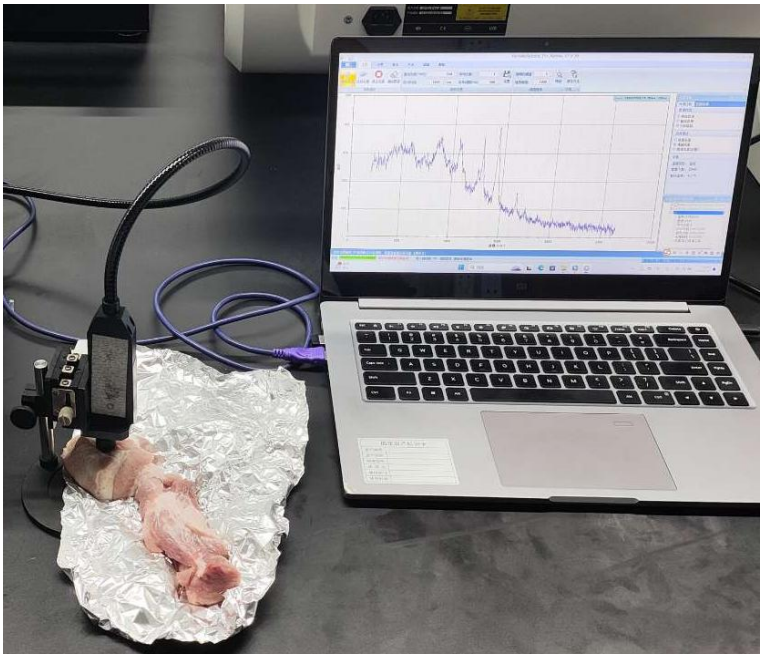

**Figure 6 Raman spectrum of fresh pork tissue measured by ATR3100**




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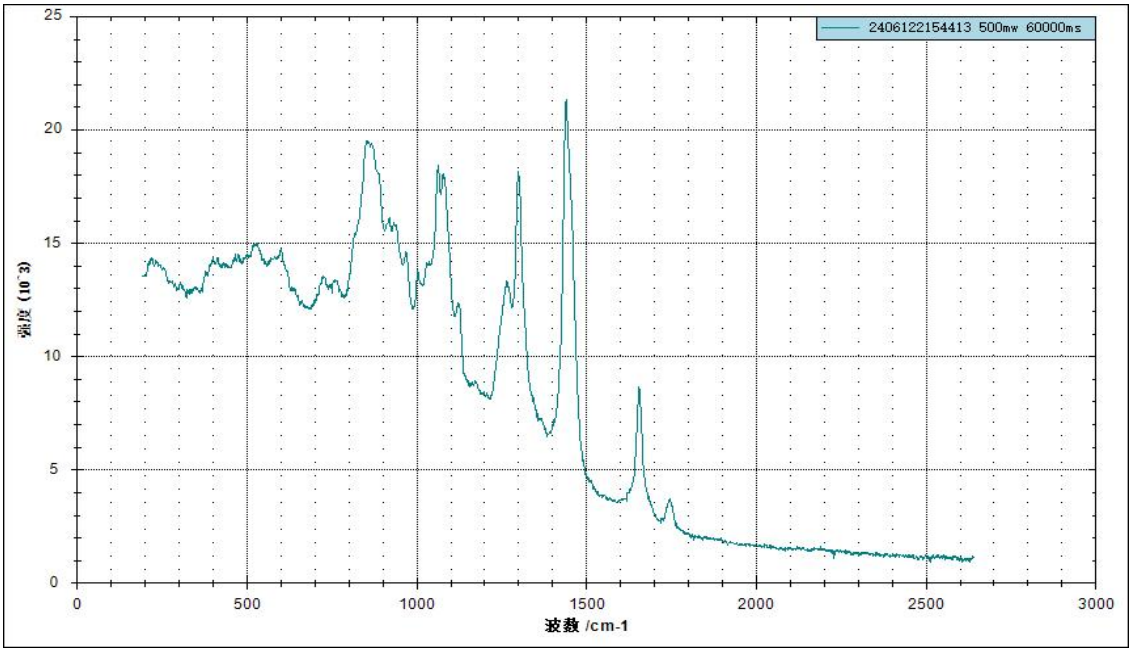


**Figure 7 Raman spectrum of pork tissue measured by ATR3100-785**

The Raman spectrum of pork tissue obtained by ATR3100 clearly shows characteristic peaks of proteins and fats at 1330 $cm^{-1}$, 1440 $cm^{-1}$, and 1650 $cm^{-1}$, demonstrating the method's reliability for chemical composition analysis. This technique shows promising applications in food composition analysis, quality control, and adulteration detection.

For banknote ink analysis using ATR3100 (785 nm excitation, 200-2700 $cm^{-1}$ range, 30 mW laser power), distinct Raman peaks were observed at:
1242 $cm^{-1}$, 1328 $cm^{-1}$, 1364 $cm^{-1}$: Corresponding to C-H deformation vibrations in aromatic rings, C-C bond stretching vibrations, and characteristic vibrations of aromatic compounds in dyes/pigments
1446 $cm^{-1}$: Attributable to C-H bending vibrations in aliphatic/aromatic compounds
1517 $cm^{-1}$ and 1636 $cm^{-1}$: Related to C=C stretching vibrations in aromatic rings or conjugated double bonds in dye molecules

These peaks indicate the presence of specific aromatic organic pigments or dyes in the banknote ink. Clear signals were obtained with integration times as short as 0.01-0.1 s, demonstrating the method's sensitivity for rapid ink analysis.




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**Figure 8 Banknote sample with yellow ink analyzed by ATR3100**

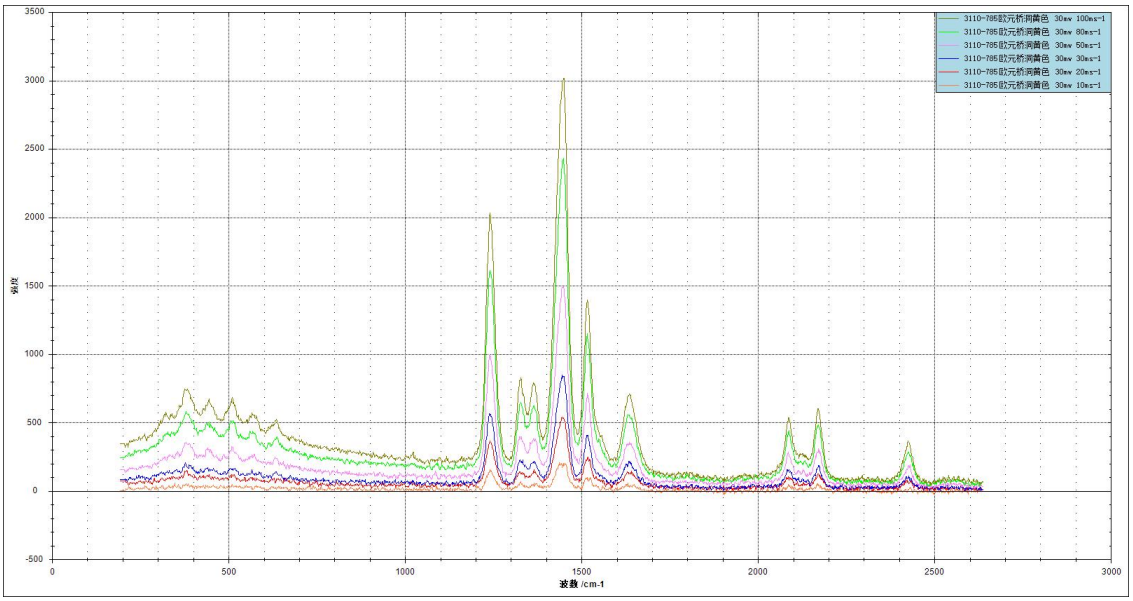


**Figure 9 Raman spectrum of banknote ink measured by ATR3100-785**

The successful detection of banknote ink by ATR3100 demonstrates three key advantages: (1) The ink contains Raman-active organic dyes/pigments with distinct and reproducible characteristic peaks; (2) The instrument's high sensitivity enables detection with low laser power (30mW) and short integration times (0.01-0.1s); (3) This method is particularly suitable for currency authentication, ink quality control, and anti-counterfeiting material research, showing significant potential in forensic analysis and anti-counterfeiting applications.

For graphite powder analysis using ATR3100 (532nm excitation, 200-5300cm$^{-1}$ range, 20mW power, 60s integration), characteristic D (1347cm$^{-1}$) and G (1571cm$^{-1}$) bands were clearly observed, enabling reliable assessment of graphitization degree. The intensity ratio (ID/IG) serves as a crucial indicator:




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- Lower ratios indicate higher graphitization degree with more perfect $sp^2$ structures
- Higher ratios suggest greater defect concentration or amorphous/edge carbon content

This analytical approach provides reliable data support for:
✓ Carbon material development
✓ Quality control protocols
✓ Process optimization
✓ Fundamental research on graphite materials

The method's combination of rapid measurement (60s) and low power requirements (20mW) makes it particularly suitable for industrial applications while maintaining analytical precision.

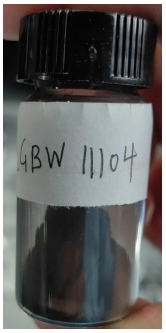


**Figure 10 Graphite powder sample**

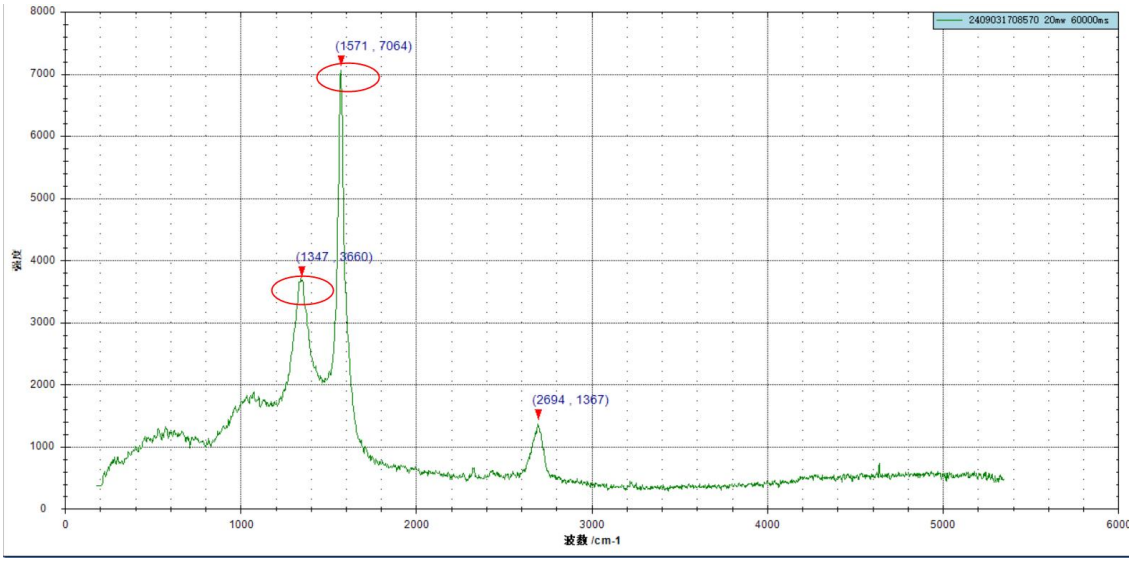


**Figure 11 Raman spectrum of graphite powder measured by ATR3100-532**

Quantitative analysis of calcium carbonate in calcium oxide was conducted using the ATR3100. The excitation wavelength was set at 785 nm, with a wavenumber range of 200-2700 $cm^{-1}$, laser power at 400 mW, and integration time of 2 seconds. Signals from both calcium oxide and calcium carbonate were detected. A linear fitting was performed using the ratio $I_{1084}/I_{280}$ (where the 1084 $cm^{-1}$ Raman peak corresponds to the symmetric stretching vibration of $CO_3^{2-}$ in calcium carbonate, serving as its characteristic peak, and the 280 $cm^{-1}$ Raman peak corresponds to the low-frequency lattice vibration of calcium

oxide crystals, a key feature distinguishing it from calcium carbonate) and their relative concentrations. The correlation coefficient $R^2$ exceeded 0.98, indicating high accuracy of the instrumental method.

This experiment demonstrates that a 2-second integration time meets the requirements for rapid detection in industrial production without damaging samples, making it suitable for real-time monitoring or analysis of high-value samples. The method exhibits excellent reliability in monitoring the ratio of calcium oxide to calcium carbonate, proving applicable for quality control in the cement industry and material composition analysis. It also provides a significant reference for the application of Raman spectroscopy in quantitative analysis of composite materials.

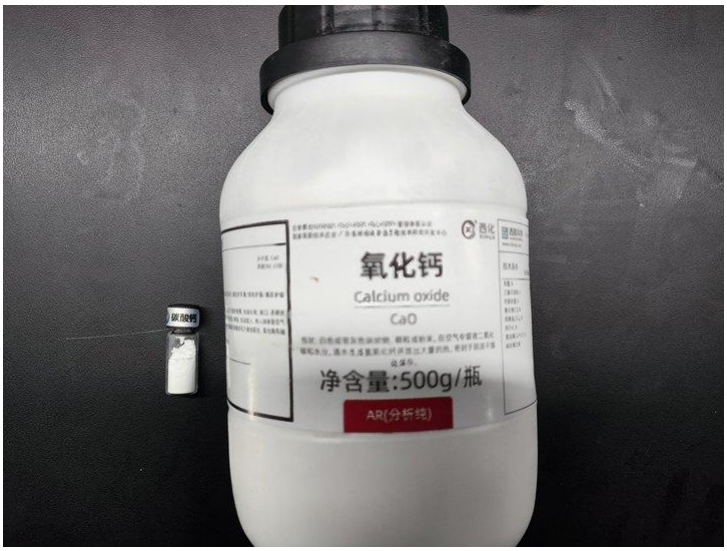


**Figure 12. Samples of calcium carbonate and calcium oxide.**

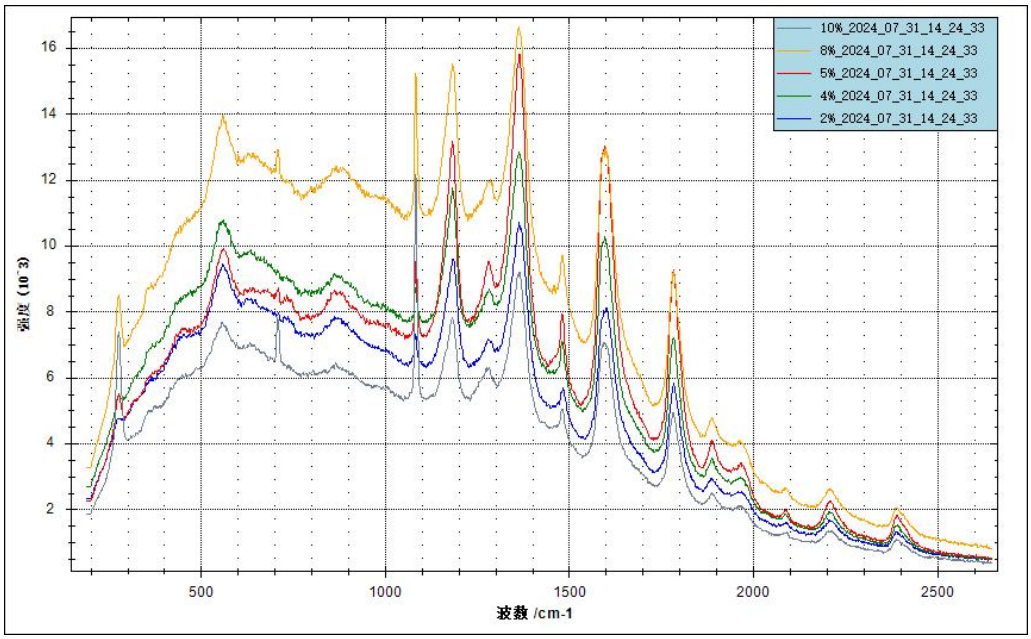

**Figure 13. Raman spectra of calcium carbonate and calcium oxide mixed powder obtained using the ATR3100-785 system.**

The detection of gastrodia elata powder was performed using the ATR3100, with an excitation wavelength of 1064 nm, a wavenumber range of 200–2600 cm−1, a laser power of 399 mW, and an integration time of 50 s. Clear characteristic peaks of gastrodia elata powder were obtained with minimal fluorescence interference.

This experiment demonstrates that the spectral performance and detection conditions of the ATR3100 are suitable for the efficient analysis of complex organic samples. The results can be applied to component identification, quality control, and authenticity verification of gastrodia elata powder, providing an accurate, non-destructive, and rapid technical approach for Raman spectroscopic analysis of natural products.

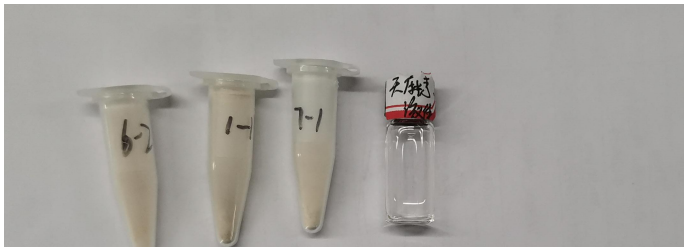

**Figure 14: Gastrodia elata Powder Sample**

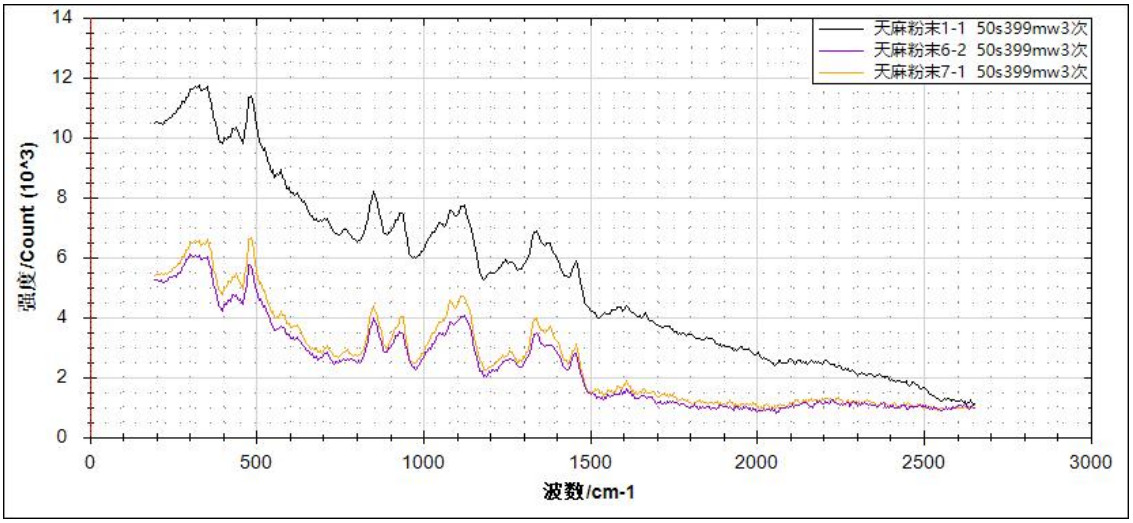


**Figure 15 ATR3100-1064 Spectrum of Gastrodia elata Powder**

The ATR3100 was used to analyze the gemstone sample with an excitation wavelength of 785 nm, a wavenumber range of 200–2600 $cm^{-1}$, a laser power of 400 mW, and an integration time of 6 s. The results revealed distinct characteristic peaks in different colored regions of the gemstone surface, indicating variations in chemical composition or crystal properties. The ATR3100 portable Raman spectrometer is well-suited for rapid, high-precision analysis of gemstone samples. Raman spectroscopy serves as a crucial non-destructive testing method in the jewelry industry, enabling applications such as material identification, quality assessment, and authenticity verification.



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**Figure 16 Photograph of the gemstone sample**

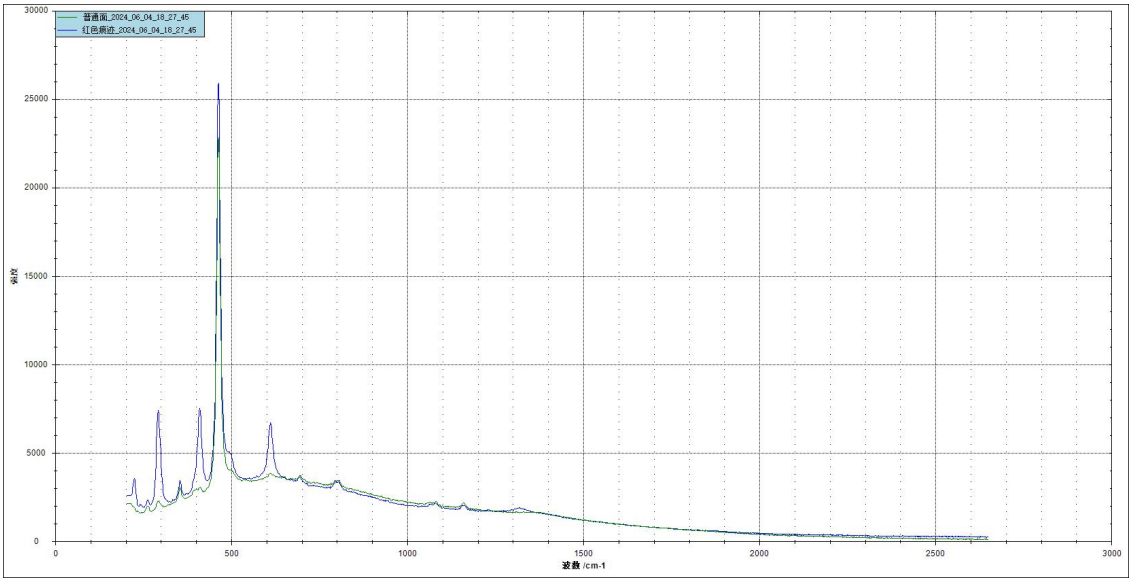


**Figure 17 Raman spectrum of the gemstone obtained using ATR3100-785**

# 3. Reliability

Figure 3.1 and Figure 3.2 showed the temperature reliability testing results of fives ATR3010 portable Raman spectrometers. The testing temperature range was from 5 oC to 40 oC. The spectrometer was kept more than 1 hour at every temperature spots. Acetonitrile was used as the standard sample in the testing. The testing results were calculated using 918 cm-1 of acetonitrile. The wavenumber shift was 1 cm-1 or less(as show in Fig. 3.1). The peak intensity variation was less than 10% (as show in Fig. 4).




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Temperature range: 5-40 centigrade
Wavenumber shift: < 1 $cm^{-1}$

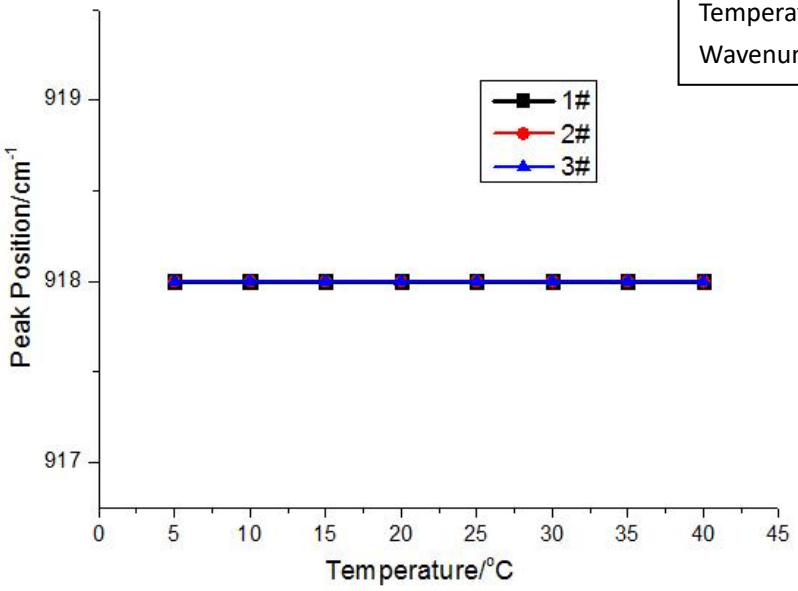
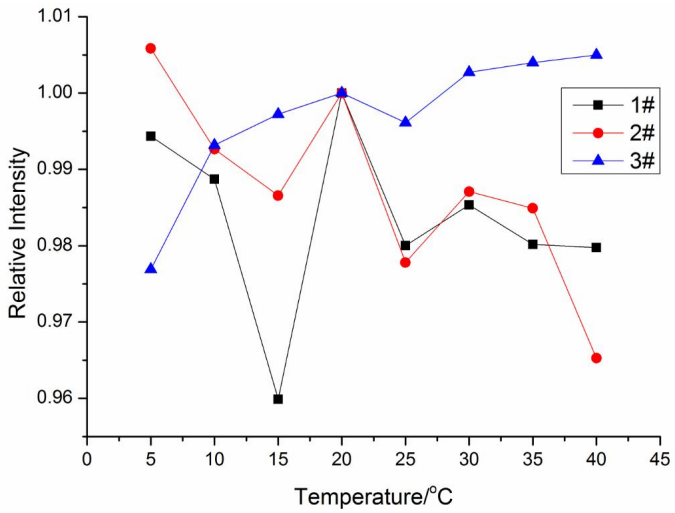



Fig. 3.1 Wavenumber shift results testing from 5 oC to 40 oC of fives ATR3010 portable Raman spectrometers




Temperature range: 5-40 centigrade
Spectral intensity variation: < 10%

Figure 3 Intensity variation testing from 5 ° to 40 ° of three ATR3010 portable Raman spectrometers

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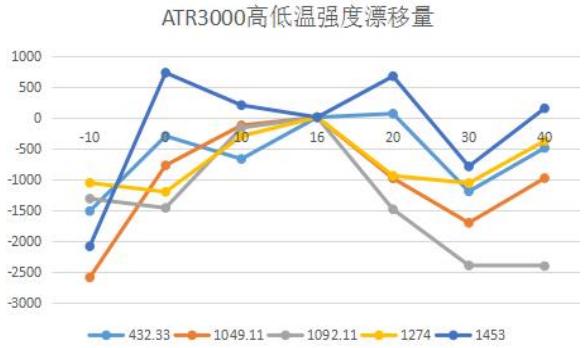


Figure 4 Intensity variation -10 °C to 40 °C of ATR3100 portable Raman spectrometers, sample is alcohol.

# 4. Ordering Information

| Model | Excitation Wavelength (nm) | Maximum Laser Power (mW) | Spectral Range ($cm^{-1}$) | Resolution ($cm^{-1}$) | Features |
|---|---|---|---|---|---|
| ATR3100-785-26 | 785 | 550 | 200~2600 | 4~6 | Suitable for most applications |
| ATR3100-785-35 | | | 200~3500 | 6~8 | |
| ATR3100-785-43 | | | 200~4300 | 7~10 | |
| ATR3100-1064-26 | 1064 | 500 | 200~2600 | 13 | No fluorescence interference – Especially suitable for dark-colored samples, highly fluorescent samples such as pigments, biological specimens, etc. |
| ATR3100-1064-34 | 1064 | 500 | 200~3400 | 20 | |
| ATR3100-830 | 830 | 550 | 200~3300 | 7 | Better penetration of human skin – Ideal for measuring biological samples, such as non-invasive glucose detection and early-stage cancer screening. |
| ATR3100-266 | 266 | 50 | 200~3000 | 25 | Proteins, DNA resonance Raman, fluorescence suppression |
| ATR3100-532 | 532 | 100 | 200~3700 | 11 | Graphene, coal, biological samples, 2D materials, SERS |



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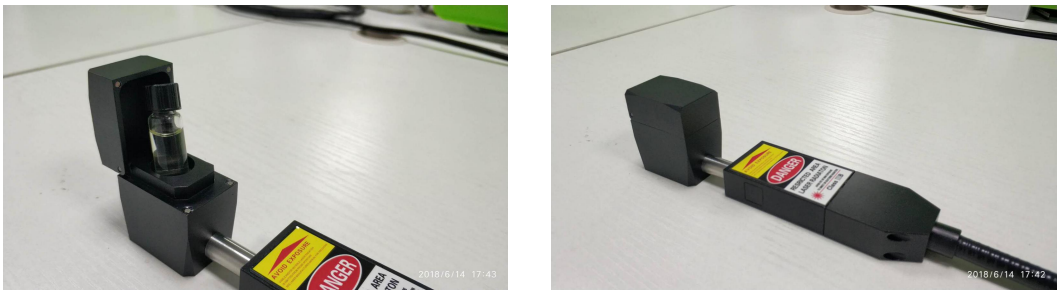
| | | | | | |
|---|---|---|---|---|---|
| | | | | | (Surface-Enhanced Raman Spectroscopy), etc. |
| ATR3100-633 | 633 | 80 | 200~3200 | 10 | Metal oxides, new materials |
| In addition to the 1064nm Raman system, the following detector options are available for other Raman configurations:<br>ATR3100PS: Ultra-high signal-to-noise ratio, back-illuminated CCD with -10° C cooling, supporting integration times up to 25 minutes.<br>ATR3100LT: Ultra-high signal-to-noise ratio, scientific-grade CCD with -15° C cooling, supporting integration times up to 1.0 hour.<br>ATR3100DC: Ultra-high signal-to-noise ratio, scientific-grade CCD with -70° C deep cooling, supporting integration times up to 1.0 hour. | | | | | |


# 5. Accessories



**Liquid Sample Measurement Cell (Thermo Vial)**

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**Liquid Sample Measurement Cell (HPLC Vial, Micro Volume) (Optional)**


**ATR20107 Gun-Type Raman Probe (Optional)**




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**Precision Adjustment Mount (For Solid/Powder Measurement)**




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