Fluorescence Rejection By Shifted Excitation Raman Difference Spectroscopy (SERDS) | INOPDRS

Feature:

- Difference Raman spectroscopy can effectively reject fluorescence;
- Dual-band aser coupling technology;
- High sensitivity and TE-Cooled CCD.
- Ultra low noise circuit;
- Powerful embedded software.
- Can eliminate fluorescent background;
- Search and display peak easy;
- Liquid crystal screen: 10.1;
- Android 6.0 operating system;
- The 11.6-inch capacitive touch screen supports multi touch control;
- USB 2.0；
- Kindly Human Machine Interaction;
- Battery > 4h;
- Support LAN remote control;
- IP67 dustproof and waterproof industry protection.

Application:

- Bioscience;
- Pharmaceutical Engineerin;
- Forensic analysis;
- Agriculture and food safet;
- Gem identification.
- Environmental Science

Description:

INOPDRS adopts the international leading Fluorescence Rejection By Shifted Excitation Raman Difference Spectroscopy (SERDS). In the shifted excitation, the Raman signal is very sensitive to the excitation, but the fluorescence signal is not sensitive. The differential technology is used to reject the fluorescence. It can directly measure high fluorescent substances, anti-interference, anti noise, improve the detection sensitivity and SNR of the whole system, filter out interference peaks (such as ambient light peak, fluorescence peak, etc.), retain only pure Raman peaks, and capture tiny signal difference.

Because it can remove all kinds of interferences such as INOPDRS portable Raman spectrometer can ensure the accuracy, and reduce the requirement of light source power, improve the reliability of the machine and the ability of spectrum fault tolerance and error correction. Combined with SERS technology, it can achieve PPB level detection capability. INOPDRS has significant reliability to makes the test results accurate and reliable.

The excellent low stray light condition makes the INOPDRS widely used, especially in biochemical analyzer, food safety, pharmaceutical engineering, etc. The multifunctional software promotes the spectrum analysis process in application. The remote experiment through Internet access makes the test project easier.

Model	Wavelength Range (cm^{-1})	Resolution (cm^{-1})
INOPDRS-27	250-2700	6
INOPDRS-35	200-3500	8
INOPDRS-43	200-4300	10

- Test according to ASTM e2529-06;
- If customized, the resolution performance can be improved

1. Working Principle

SERDS, also known as frequency shift excitation method, uses two slightly different wavelengths of laser to irradiate the sample to get two original Raman spectra. The fluorescence background does not move with the slight change of laser wavelength, but the position of Raman peak will change obviously. The difference spectrum is obtained by subtracting the two spectra. In the difference spectrum, the fluorescence background phase changes There is no fluorescence interference.

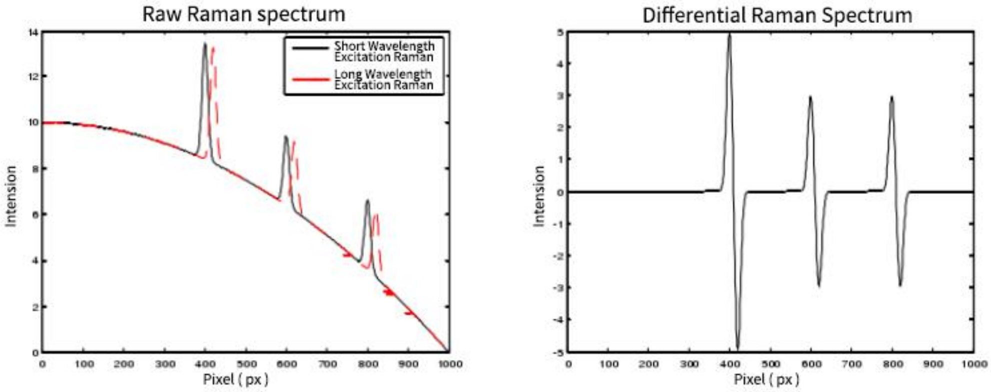


Fig. 1 (a) the original Raman spectra (the realized and dotted lines represent the Raman spectra excited by 784.5nm and 785.5nm laser respectively); (b) the differential spectra

In the ideal case, the normal Raman spectrum can be easily recovered from the difference spectrum by using the accumulation method and convolution method. However, the actual measured spectral signals are more or less noisy, such as dark current noise of photodetector, circuit thermal noise, ambient background light noise, stray light inside spectrometer, etc., as shown in Fig 2.5. The existence of noise will not only affect the measurement SNR, but also reduce the performance of the restoration algorithm.

Compared with the laboratory Raman system, the portable Raman spectrometer has worse signal-to-noise ratio and more serious noise interference. In addition to noise interference, the intensity of positive and negative peaks may be inconsistent and asymmetric in the actual differential spectrum, which will also reduce the performance of the differential spectrum restoration algorithm.

The intensity of Raman signal is inversely proportional to the fourth power of the wavelength. Although there is only a small difference between the two excitation wavelengths of the SERDs system, this small difference will lead to the asymmetry of Raman peak. The noise interference superimposed on the spectrum peak will also cause the spectrum peak asymmetry. In addition, the different temperature and the slight change of fluorescence characteristics (photobleaching) also lead to asymmetric peaks.

Optosky has developed a new differential Raman reconstruction algorithm raman, which can perfectly solve the problems of noise and asymmetry.

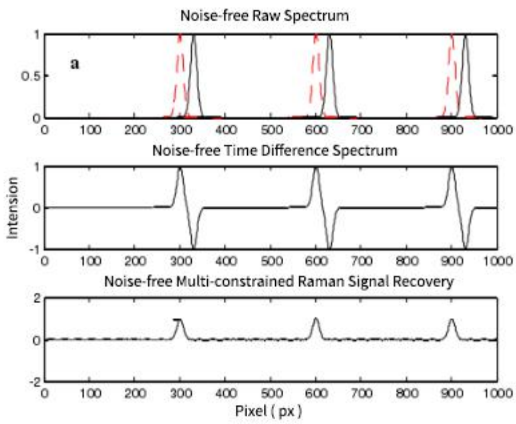


Fig. 2 signal recovery of differential Raman

2. Parameter

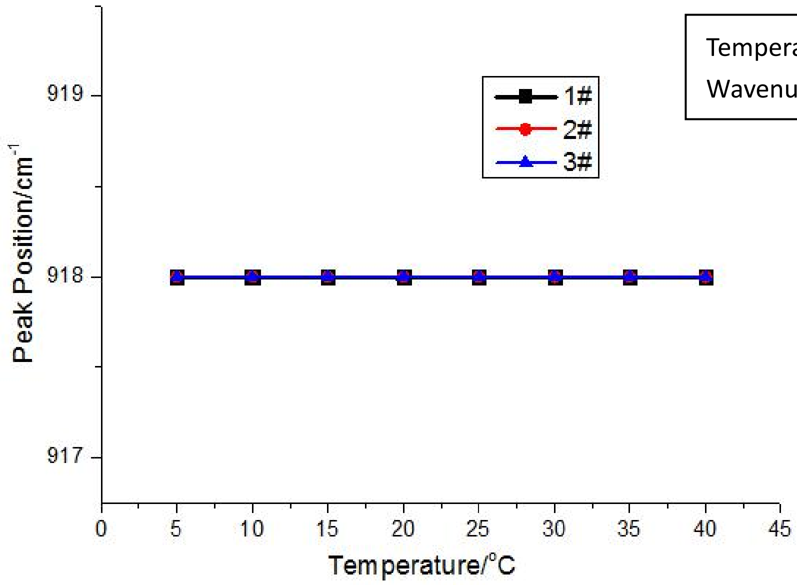
INOPDRS			
Interface	USB 2.0 & WIFI		
Operating system	Android 6.0		
Screen	11.6 'capacitive touch screen, multi touch		
Battery power supply	>4 h		
Integration time	4ms - 120s		
Supply voltage	DC 19V(+/-5%)		
Working Temperature	-10~40 ℃		
Working Humidity	< 95%		
Dimension(L*W*H)	40×30×18 cm^3		
Weight	7.8 Kg		
Reliability			
Spectral stability	σ/μ < 0.5%　(COT 8 hours)		
Temperature stability	Spectral shift ≤ 1 cm^{-1} (10-40 ℃)		
Spectral intensity change （in 5 ~ 40 ℃)	<±5%		
Optical parameter			
Wavelength range (cm^{-1})	250-2700	200-3500	200-4300
Resolution (cm^{-1})	6	8	10
SNR	>3000:1 (918 cm^{-1} of Acetonitrile，10s accumulation, 200mW)		
Slit width	50 μm		
Focus	98 mm for incidence and output		
Detector			
Model	Ultra high sensitivity and fast cooling CCD		

Datasheet

Cooling temperature	-10 ℃
Detection range	200-1100 nm
Effective pixel	2048 pixels
Dynamic range	50000：1
Full well capacity	300 Ke^-
Sensitivity	QE>40%, 6.5 μV/e-
Excitation	
Central wavelength	Built in two lasers with central wavelengths of 784.5nm & 785.5nm
Half peak width	0.08 nm
Output power	≥500 mW
Power reliability	σ/μ <±0.2%
Raman probe	
Working distance	6 mm
Transmittance	OD>8
NA	0.3
Aperture	7mm

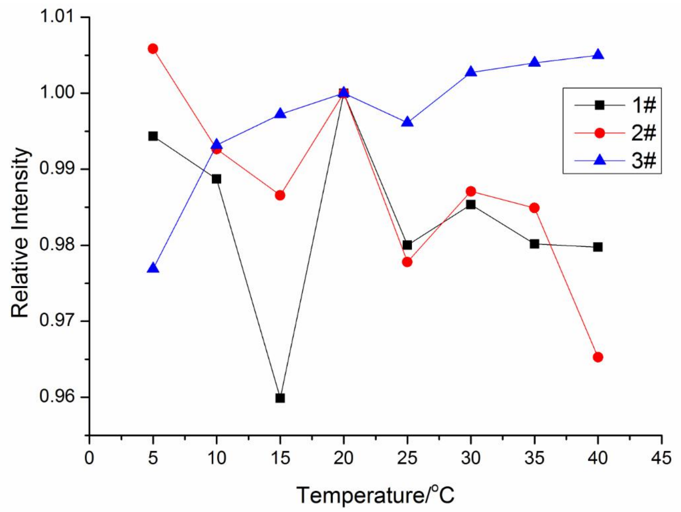
Fig. 3 physical picture of INOPDRS

3. Reliability Test



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

Fig. 4 Wave number shift test of INOPDRS SERDS (5 ~ 40 ° C)



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

Fig. 5 signal strength stability test of INOPDRS SERDS (5 ~ 40 ° C)

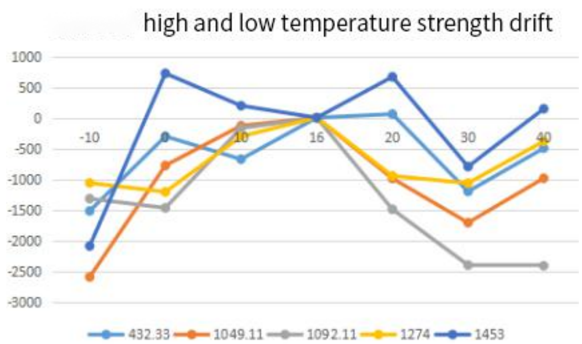


Fig. 6 Peak intensity stability test of INOPDRS SERDS

4. Measurement Accessories

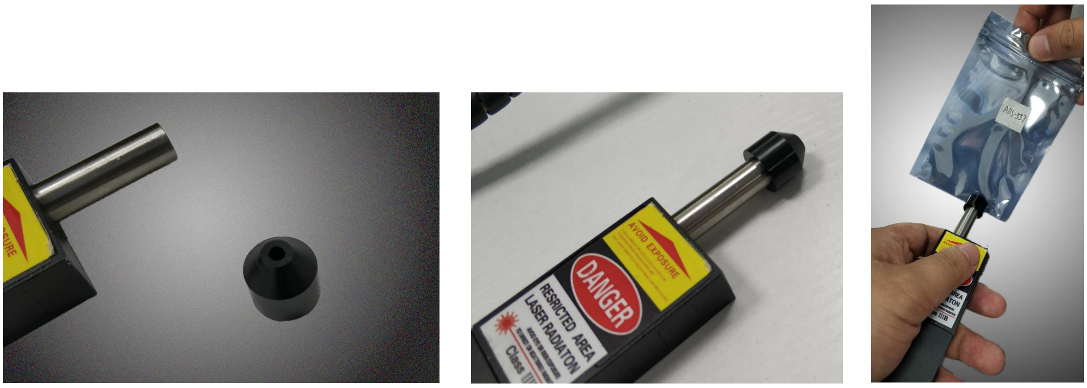


Fig. 7 Solid and powder measuring probe

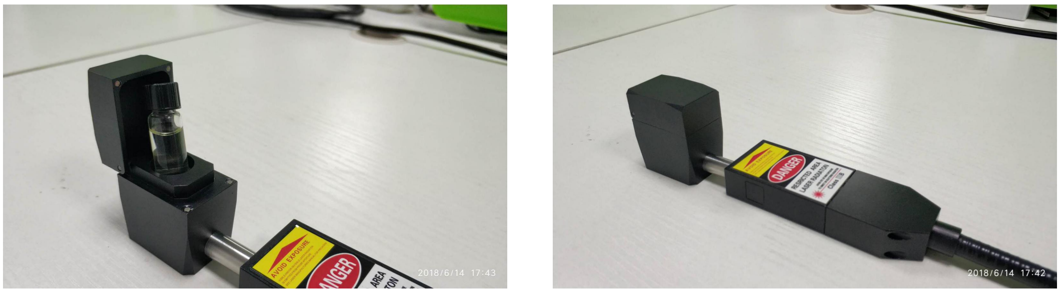


Fig. 8 Liquid sample measuring cell (thermo bottle)

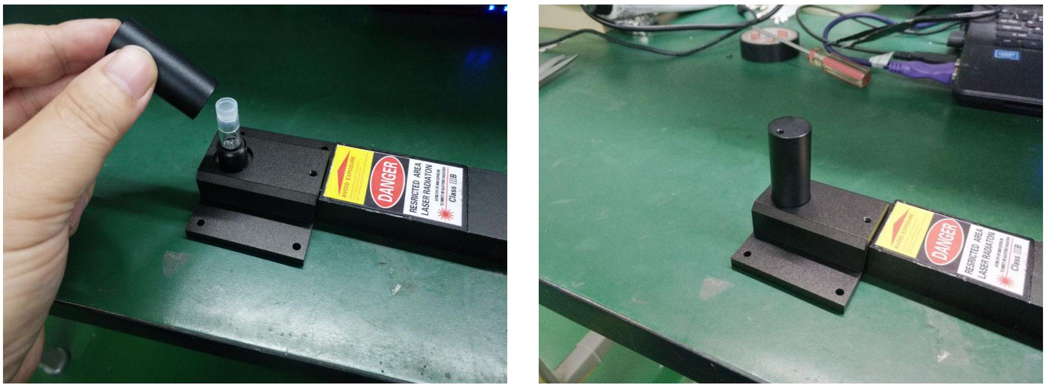


Fig. 9 Liquid sample measuring cell (liquid chromatography bottle, micro) (optional)

Fig. 10 gun Raman probe (optional))

Fig. 11 Test adjusting frame (optional)

5. Differential Raman Application:

5.1. Identification and analysis of plastics by SERDS

Jiang Hong and others from the school of investigation and criminal science and technology of people's Public Security University of China used SERDS to inspect 42 plastic bottles of different brands, different manufacturers and different capacities. According to the SERDS, the samples can be divided into polyethylene and polyethylene terephthalate, and the Raman characteristic peaks of each type of samples are different. Using discriminant analysis method to analyze the processed spectral data, eight discriminant functions are established to predict the value of data variables. At the same time, the discriminant ability of the above discriminant functions is tested, and the discriminant distribution map is established. The centroids of nine groups of samples in the discriminant map are obviously distinguished, and the effect is better.

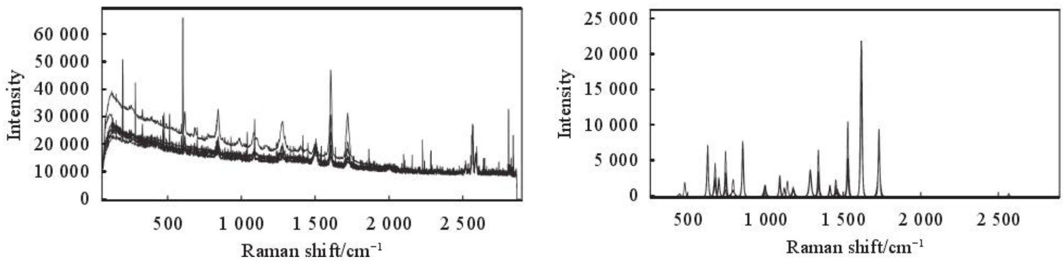


Fig. 12 Conventional Raman spectra (left) and differential Raman spectra (right) of plastic samples

5.2. Identification of sole materials by differential Raman

Sports shoes have become the necessities of people's daily travel. As a kind of common material evidence, sports shoes soles often appear in all kinds of criminal cases and traffic accident scenes. Through the inspection of the extracted material evidence, it can provide clues and directions for the detection of cases, and provide scientific evidence for the confirmation of crimes. With the rapid development of chemical and polymer materials, sole materials have evolved from leather and natural rubber (NR) to new materials with various properties.

At present, the main methods of testing sole materials are infrared spectroscopy, X-ray fluorescence spectrometry, scanning electron microscopy / energy dispersive spectrometry, etc. SERDS has the advantages of nondestructive testing, short processing time and simple operation. It can directly measure high fluorescence substances, filter out interference peaks (such as ambient light peak, PL peak, etc.), and improve the detection sensitivity and signal-to-noise ratio of the whole system.

Jiang Hong and others from the school of investigation and criminal science and technology, people's Public Security University of China, used SERDS to test 40 white sports shoes soles, and combined with the system cluster analysis to process the experimental data, in order to provide a certain reference for the differentiation of sports shoes soles evidence in court science.

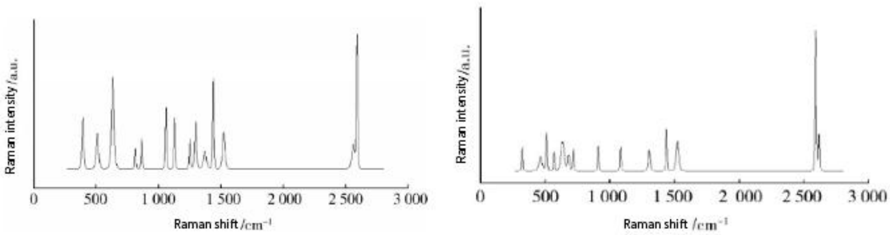


Fig. 13 differential Raman spectra of common sole materials (a) ethylene vinyl acetate copolymer EVA; (b) polyvinyl chloride (PVC)

5.3. SERDS for the identification and analysis of cigarette packaging film materials

Cigarette case outer packaging film refers to a layer of film wrapped outside cigarette case, which can be divided into three categories according to the main components: Biaxial polypropylene film (BOPP), cellulose film and ethylene propylene composite film (EPM). BOPP is most widely used in the production of cigarette packaging film in the market.

At present, the inspection methods of cigarette packaging film mainly include infrared spectroscopy, Raman spectroscopy, differential scanning calorimetry, X-ray fluorescence spectrometry, small angle laser scattering, overall separation trace comparison and so on. As a new method, SERDS has not been applied to the study of cigarette evidence. It not only has the characteristics of non-destructive testing materials and simple operation, but also can directly measure high fluorescent substances, filter out background noise, effectively reduce interference and improve the overall signal-to-noise ratio of the system.

Zhang Jin and others from the school of investigation and criminal science and technology of people's Public Security University of China have carried out a lot of experiments on different cigarette packaging materials by using SERDS, and achieved very good results.

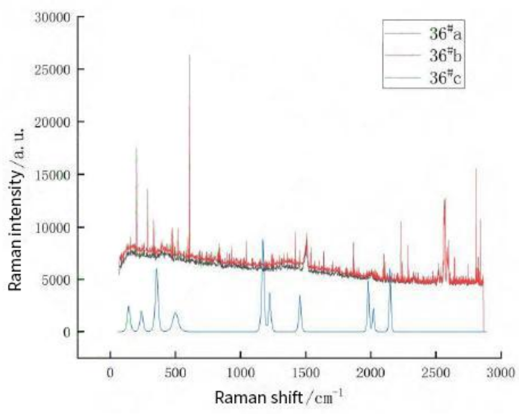


Figure 14 conventional Raman spectra (36 # A and 36 # b) and differential Raman spectra (36 # C) of cigarette case outer packaging film materials

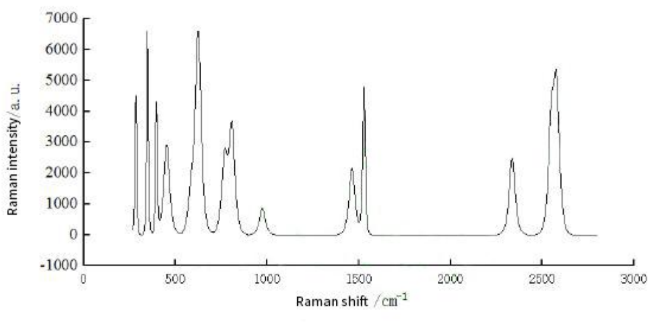


Fig. 15 differential Raman spectra of common cigarette packaging materials

5.4. Identification of Staphylococcus epidermidis by SERDS

Rapid detection of food borne pathogens has always been one of the hot issues in agricultural food safety, which needs to be paid enough attention by the whole society. Rapid detection of food borne pathogens has always been one of the hot issues in agricultural food safety, which needs to be paid enough attention by the whole society. With the advantages of accuracy and specificity, it has gradually become a strong technical support for agricultural food supervision.

Xu Mingzhu of Tarim University used the newly developed method of combining differential Raman technology and surface enhanced technology to obtain the fingerprint of related microorganisms, which was incorporated into the database. So as to achieve the rapid and accurate detection of all kinds of microorganisms.

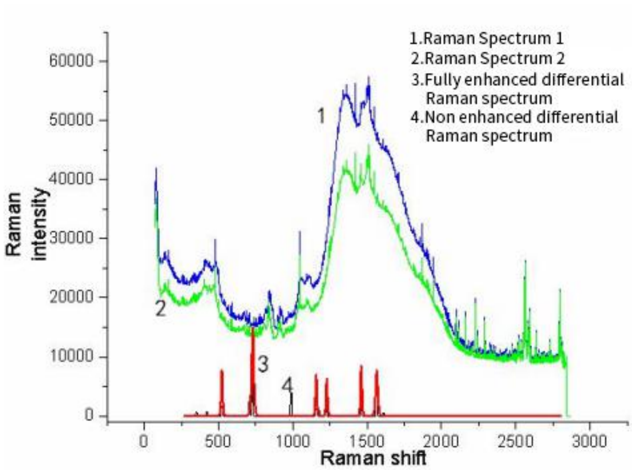


Fig. 16 differential Raman spectrum of Staphylococcus epidermidis; blue: Raman spectrum 1 of Staphylococcus epidermidis with colloidal gold; green: Raman spectrum 2 of Staphylococcus epidermidis with colloidal gold; red: differential Raman spectrum of Staphylococcus epidermidis with colloidal gold; Black: differential Raman spectrum of Staphylococcus epidermidis without enhancer.