PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : G01N 21/65	A1	(11) International Publication Number: WO 89/ 01622
		(43) International Publication Date: 23 February 1989 (23.02.89)

(21) International Application Number: PCT/US88/02688

(22) International Filing Date: 8 August 1988 (08.08.88)

(31) Priority Application Number: 085,530

(32) Priority Date: 14 August 1987 (14.08.87)

(33) Priority Country: US

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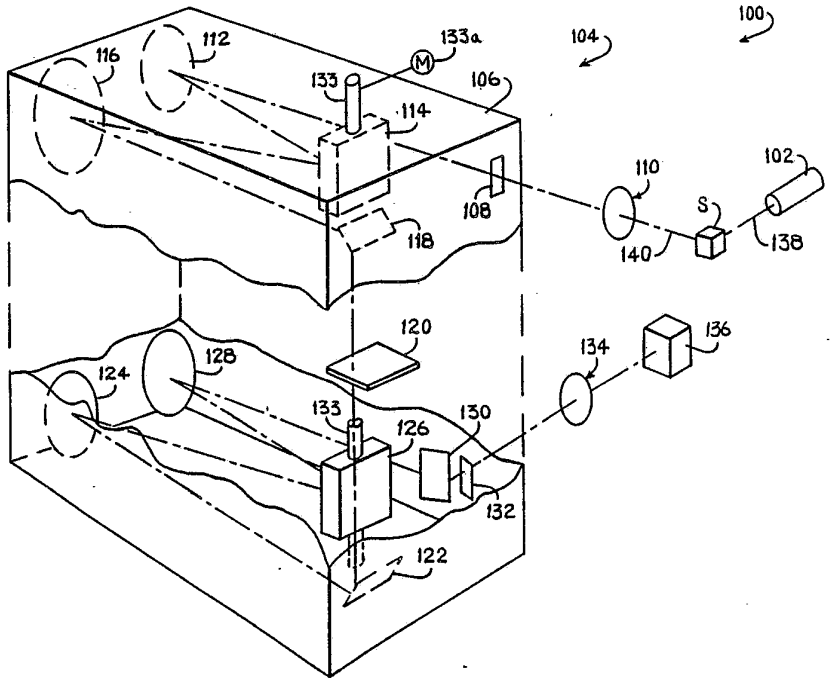
(81) Designated States: AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent).

Published
With international search report.
With amended claims.

Date of publication of the amended claims:
23 March 1989 (23.03.89)

(54) Title: RAMAN SPECTROMETER HAVING HADAMARD ELECTROOPTICAL MASK AND DIODE DETECTOR



(57) Abstract

A Raman spectrometer device is provided which provides useful spectral information in situations where Raman spectroscopy has heretofore been unworkable. The spectrometer (100) makes use of a stationary electrooptical masking device (120) in lieu of conventional slit scanning optics, with the mask (120) being computer controlled to provide a multiplexing function, typically employing Hadamard mathematics. The stationary encoding mask permits use of a relatively inexpensive photodiode detector, as compared with photomultiplier tubes conventionally used in Raman instrumentation. Advantageously, unwanted Rayleigh scattered radiation can be completely eliminated, either by blanking those zones of the mask (120) receiving such radiation, or physically locating the device in such orientation that the Rayleigh scattered radiation does not pass through operative portions of the mask (120).

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AMENDED CLAIMS

[received by the International Bureau on 14 February 1989 (14.02.89) original claims 1, 2, 5 - 9 cancelled; new claims 10 - 26 added; other claims unchanged (7 pages)]

1. (Cancelled)

2. (Cancelled)

3. The spectrophotometer of Claim 15, said detector being a photodiode detector.

4. The spectrophotometer of Claim 15, said source being operable for generating monochromatic radiation having a wavelength of from about 0.1 to 2.0 microns.

5. (Cancelled)

6. (Cancelled)

7. (Cancelled)

8. (Cancelled)

9. (Cancelled)

10. An apparatus for detecting Raman spectra in electromagnetic radiation emanating from a sample to be analyzed as a result of directing a beam of monochromatic light from a source thereof into the sample, the radiation including Raman and Rayleigh scattered radiation, said apparatus comprising:

dispersing means for receiving and dispersing said radiation as dispersed radiation along a path, said dispersed radiation including Raman and Rayleigh scattered radiation;

a stationary, electro-optical device situated for impingement of at least a portion of said dispersed radiation thereon and including --

a body presenting a pair of opposed faces,

zone defining means carried by said body for dividing at least one of said faces into a plurality of discrete, electrically alterable zones, and

zone altering means operably coupled with said zone defining means for selective alteration of each zone respectively between a relatively transmissive condition relative to said dispersed radiation and a relatively opaque condition relative to said dispersed radiation;

means for preventing passage of Rayleigh scattered radiation present in said dispersed radiation through relatively transmissive ones of said zones during analysis of the sample and for allowing passage of at least a portion of said

Raman scattered radiation present in said dispersed radiation through transmissive ones of said zones during analysis of the sample;

dedispersing means for receiving and dedispersing radiation passing through transmissive ones of said zones; and

detector means for receiving and detecting dedispersing radiation from said dedispersing means in order to detect Raman spectra thereof.

11. The apparatus as set forth in Claim 10, further including a laser as said source of said monochromatic light beam and means for directing said beam into the sample.

12. The apparatus as set forth in Claim 10, said masking device including a liquid crystal masking device.

13. The apparatus as set forth in Claim 10, said zone altering means including --

means for successively and sequentially changing over time in a predetermined fashion the patterns of said zones altered relatively transmissive and opaque during analysis of the sample, and

means operably connected with said detector means for successively receiving and analyzing detected radiation information from said detector means during each of said patterns in order to provide a spectral analysis.

14. The apparatus as set forth in Claim 10, said preventing means including means for selectively adjusting said path of said dispersed radiation in order to prevent impingement of said Rayleigh scattered radiation on transmissive ones of said zones.

15. The apparatus as set forth in Claim 10, said Rayleigh scattered radiation present in said dispersed radiation impinging on certain ones of said zones, said preventing means including means for altering said certain ones of said zones to said relatively opaque condition thereby preventing passage of said Rayleigh scattered radiation through relatively transmissive ones of said zones.

16. The apparatus as set forth in Claim 10, said zone altering means including a microcomputer.

17. The apparatus as set forth in Claim 10, said detector means including a photodiode.

18. In a method of detecting Ramam spectra including the steps of directing a beam of monochromatic light into a sample to be analyzed, and collecting electromagnetic radiation emanating from the sample as a result of the beam, the radiation including Raman and Rayleigh scattered radiation, the improvement which comprises the steps of:

dispersing the radiation emanating from the sample as dispersed radiation along a path, said dispersed radiation including Raman and Rayleigh scattered radiation;

providing and positioning a stationary elecro-optical masking device for impingement of at least a portion of said dispersed radiation thereon wherein said masking device includes --

a body presenting a pair of opposed faces,

zone-defining means carried by said body for dividing at least one of said faces into a plurality of discrete, electrically alterable zones, and zone-altering means operably coupled with said zone-defining means for selective alteration of each zone respectively between a relatively transmissive condition relative to said dispersed radiation and a relatively opaque condition relative to said dispersed radiation;

preventing passage of Rayleigh scattered radiation present in said dispersed radiation through relatively transmissive ones of said zones during

analysis of the sample and allowing passage of at least a portion of said Raman scattered radiation present in said dispersed radiation through relatively transmissive ones of said zones during analysis of the sample;

dedispersing radiation passing through relatively transmissive ones of said zones by use of a dedispersing device; and

detecting the dedispersed radiation from said dedispersing device in order to detect Raman spectra thereof.

19. The improvement as set forth in Claim 18, further including the step of providing a laser as the source of the beam of monochromatic radiation and directing the beam into the sample.

20. The improvement as set forth in Claim 18, further including the step of detecting the dedispersed radiation with a photodiode.

21. The improvement as set forth in claim 18, said monochromatic radiation having a wavelength of from about 0.1 to 2.0 microns.

22. The improvement as set forth in Claim 18, said masking device including a liquid crystal masking device.

23. The improvement as set forth in Claim 18, further including the steps of:

successively and sequentially changing over time in a predetermined fashion the patterns of said zones altered relatively transmissive and opaque during analysis of the sample, and

successively receiving and analyzing detected radiation information from said detector means during each of said patterns in order to provide a spectral analysis.

24. The improvement as set forth in Claim 18, said preventing step including the step of selectively adjusting said path of said dispersed radiation in order to prevent impingement of said Rayleigh scattered radiation on transmissive ones of said zones.

25. The improvement as set forth in Claim 18, said Rayleigh scattered radiation present in said dispersed radiation impinging on certain ones of said zones, said preventing step including the step of altering said certain ones of said zones to said relatively opaque condition thereby preventing passage of said Rayleigh scattered radiation through relatively transmissive ones of said zones.

26. The improvement as set forth in Claim 18, said zone altering means including a microcomputer.