(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 December 2012 (13.12.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/170269 A1

(51) International Patent Classification:
G07D 7/12 (2006.01)

(21) International Application Number:
PCT/US2012/040109

(22) International Filing Date:
31 May 2012 (31.05.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
13/156,620 9 June 2011 (09.06.2011) US

(71) Applicant *(for all designated States except US)*: **EASTMAN KODAK COMPANY** [US/US]; 343 State Street, Rochester, NY 14650-2201 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **PAWLIK, Thomas, D.** [DE/US]; 343 State Street, Rochester, NY 14650-2201 (US). **OLM, Myra, Toffolon** [US/US]; 343 State Street, Rochester, NY 14650-2201 (US). **HENRY, Mark, P.** [US/US]; 343 State Street, Rochester, NY 14650-2201 (US).

(74) Common Representative: **EASTMAN KODAK COMPANY**; 343 State Street, Rochester, NY 14650-2201 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) **Title**: AUTHENTICATION OF A SECURITY MARKER

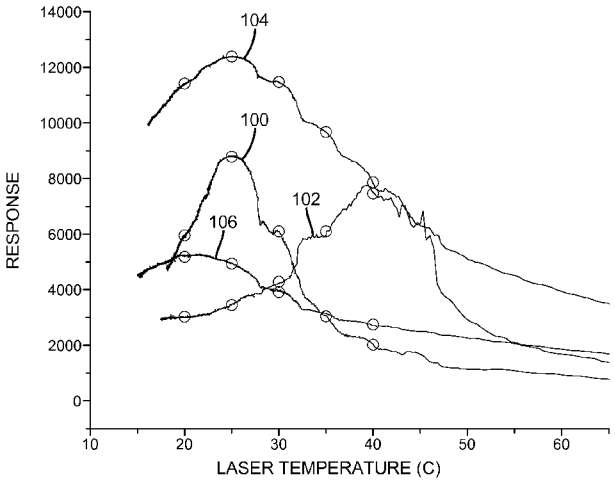

FIG. 5

(57) **Abstract**: A method for authenticating security markers includes illuminating the security marker with a laser, detecting an optical response from the security marker, changing a temperature of the laser to vary the wavelength of radiation produced by the laser; detecting changes in the optical response from the security marker as the wavelength of the radiation changes, comparing the optical response profile from the security marker as it varies with changes in wavelength to a reference profile; and authenticating the security marker if the optical response profile matches the reference profile.

WO 2012/170269 A1

AUTHENTICATION OF A SECURITY MARKER

FIELD OF THE INVENTION

The present invention relates in general to authenticating objects and in particular to using the temperature dependence of the wavelength of lasers as a means to identify an authentic object.

BACKGROUND OF THE INVENTION

Many high value products are subject to counterfeiting and there is a need to authenticate objects to differentiate the objects from counterfeits. One method of authenticating objects incorporates an optically active compound in a marker on the object. The marker is illuminated and the luminescence from the optically active compounds is detected. Subject to certain algorithms the marker is either authenticated or rejected. Optically active compounds with narrow excitation bands are often preferred because they have distinct optical properties. However, when illuminated with a light source with a wide bandwidth, such as a LED, they often cannot be distinguished from one another. Even if a narrow bandwidth illumination source with fixed wavelength were available, the optical response would only be determined at one wavelength and it would for example be ambiguous whether the optical response was low in luminescence intensity because the level of the optically active compound was low or the wavelength of illumination was mismatched with the wavelength of the excitation band. Therefore, a tunable narrow illumination source would be useful in order to identify specific optically active compounds. One can obtain a narrower bandwidth of illumination by using a wavelength-dispersive element such as a grating, filter or prism in the pathway of the illuminating light. However, these components increase the space requirements for the detection system and decrease the sensitivity of detection.

SUMMARY OF THE INVENTION

Briefly, according to one aspect of the present invention a method for authenticating security markers includes illuminating the security marker with a laser, detecting an optical response from the security marker, changing a temperature of the laser to vary the wavelength of radiation produced by the laser; detecting changes in the optical response from the security marker as the

wavelength of the radiation changes, comparing the optical response profile from the security marker as it varies with changes in wavelength to a reference profile; and authenticating the security marker if the optical response profile matches the reference profile.

The invention and its objects and advantages will become more apparent in the detailed description of the preferred embodiment presented below.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a plan view of a security marker detection system;

FIG. 2 shows a block diagram of a security marker detection system;

FIG. 3 shows the excitation and emission spectra of two markers;

FIG. 4 shows the temperature profile of the security marker detection system for several markers;

FIG. 5 shows the temperature profile of the security marker detection system for several markers where certain data points have been highlighted; and

FIG. 6 shows a table of response values extracted from FIG. 5 and compares them to response values of an unknown marker.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will be directed in particular to elements forming part of, or in cooperation more directly with the apparatus in accordance with the present invention. It is to be understood that elements not specifically shown or described may take various forms well known to those skilled in the art.

Referring now to FIG. 1, which shows a security marker detection system 10 which can be used to detect emission of security marker materials. FIG. 1 also shows the item to be authenticated 18. Authentication is performed by pressing the test button 12. The result is displayed by either a pass indicator light 14 or a fail indicator light 16.

Referring now to FIG. 2 which shows a security marker detection system 39 which can be used to detect emission of security marker materials in a non image-wise fashion. One or more irradiation sources 22 direct electromagnetic radiation towards the item to be authenticated 18. The authentic

item contains a random distribution of marker particles 20 either in an ink or in an overcoat varnish. The marker particles emit electromagnetic radiation 26 as a response to the radiation from the irradiation sources 22 which is detected by a photodetector 40. A microprocessor 30 analyzes the photodetector signal and determines a pass or fail indication which is displayed on the authentication indicator 32. Pass or fail indication can, for example, represent authentic and non-authentic, respectively. The irradiation sources 22 are thermally coupled to a temperature sensor 28 and heating/cooling element 29, which are also controlled by the microprocessor 30. The intensity of the emitted light from each individual marker depends in the illumination intensity and the overlap between the spectral band of the illuminating radiation and the spectral shape of the excitation band of the marker. If a semiconductor laser is used as an excitation source, the illumination has a narrow bandshape, but the wavelength of illumination varies with the temperature of the laser. The emission wavelength will shift to longer wavelength with increasing temperature and to shorter wavelengths with decreasing temperature. Typical shifts are 0.3 nm/ °C. For security markers with a narrow excitation band, the response of the security marker detection system will vary with the temperature of the illumination source. The invention makes use of this effect by collecting the marker response for a plurality of laser temperatures that correspond to different excitation wavelengths.

This measurement is initiated by pressing the test button 12. The laser temperature is changed by the heating/cooling element 29 and measured by the temperature sensor. After the measurement has ended, the marker response at the various temperatures is compared to stored marker responses for a variety of possible markers. A pass/fail decision is based on a whether the measured response matches the intended marker profile.

Referring now to FIG. 3 which shows typical excitation spectra of two emissive materials, $Y_3Al_5O_{12}:Pr^{3+}$ 80 and $KY_3F_{10}:Pr^{3+}$ 82. The Pr^{3+} ion is the emissive element in these materials. Because it is embedded in a different host matrix ($Y_3Al_5O_{12}$ in the first case and KY_3F_{10} in the second case) the excitation spectra are shifted slightly. For example, the excitation maximum of $Y_3Al_5O_{12}:Pr^{3+}$ is slightly longer in wavelength than 450. A semiconductor laser

that emits light at a wavelength of 450 nm at room temperature (22°C) is a suitable excitation source for these markers. If a temperature scan of the laser is conducted and the marker response is collected at various temperatures, it can be expected that the response profile of $Y_3Al_5O_{12}:Pr^{3+}$ will be different from the response profile of $KY_3F_{10}:Pr^{3+}$, thus enabling the security marker detection system to distinguish between the two markers.

Referring now to FIG. 4 which shows a selection of measured marker response profiles using the security marker detection system. The response profiles were obtained during separate temperature scans.

Referring now to FIG. 5 which shows an example of how discrete response values can be extracted from the measured profiles at equidistant temperature increments.

Referring now to FIG. 6 which shows a table of response values for marker 100, 102 and an unknown marker and columns a-c. The normalized response is shown in columns d-f. From the normalized response, variances of response are calculated for the unknown marker versus the markers 100 and 102 (columns g and h). The mean square variance given at the bottom of columns g and h is clearly lower for the pairing of unknown marker and marker 102 than for the pairing of unknown marker and marker 100. The security marker detection system can use this method to identify the unknown marker as marker 102 and base the pass/fail response on whether marker 102 was the intended/expected marker for the authentic item. It should be obvious for people skilled in the art that other methods exist to quantify similarities between response curves.

The emission wavelength of a semiconductor laser does not only vary with temperature, but also can be subject to manufacturing tolerances. This variability can be compensated, for example, by determining a temperature offset for a particular laser at a predetermined temperature that is correlated with the deviation of the emission wavelength this laser from a calibrated laser at the same temperature. This offset value is then used by the microcontroller to correct the measured temperature and replace it with a “wavelength adjusted” temperature.

PARTS LIST

10	security marker detection system
12	button to initiate authentication
14	authentication indicator pass
16	authentication indicator fail
18	marked item to be authenticated
20	security marker particle
22	irradiation source
24	exciting electromagnetic radiation
26	emitted electromagnetic radiation
28	temperature sensor
29	heating/cooling element
28	camera module
30	microprocessor
32	authentication indicator
39	authentication device employing non image-wise detection
40	photodetector
80	excitation spectrum of $Y_3Al_5O_{12}:Pr^{3+}$
82	excitation spectrum of $KY_3F_{10}:Pr^{3+}$
100	Marker A
102	Marker B
104	Marker C
106	Marker D

CLAIMS:

1. A method for authenticating security markers comprising:

illuminating the security marker with a laser or LED;

detecting an optical response from the security marker;

changing a temperature of the laser or LED to vary the wavelength of radiation produced by the laser or LED;

detecting changes in the optical response from the security marker as the wavelength of the radiation changes;

comparing the optical response profile from the security marker as it varies with changes in wavelength to a reference profile; and

authenticating the security marker if the optical response profile matches the reference profile.

2. The method of claim 1 comprising:

the temperature of the laser or LED is increased over a predetermined range.

3. The method of claim 1 comprising:

the temperature of the laser or LED is decreased over a predetermined range.

4. The method of claim 1 comprising:

the temperature of the laser or LED is decreased over a predetermined range; and

the temperature of the laser or LED is increased over a predetermined range.

5. The method of claim 1 wherein:

the laser or LED is in contact with a temperature sensor and a heating or cooling element or both.

6. The method of claim 1 wherein:

a temperature offset is determined based on the deviation of the wavelength of the laser or LED from the wavelength of a calibrated laser at a predetermined temperature and used as a calibration parameter.

7. The method of claim 1 wherein:

the security marker comprises at least one optically active element.

8. The method of claim 7 comprising:

the optically active element is selected from a group consisting of emissive or absorptive or combinations of both optically active elements.

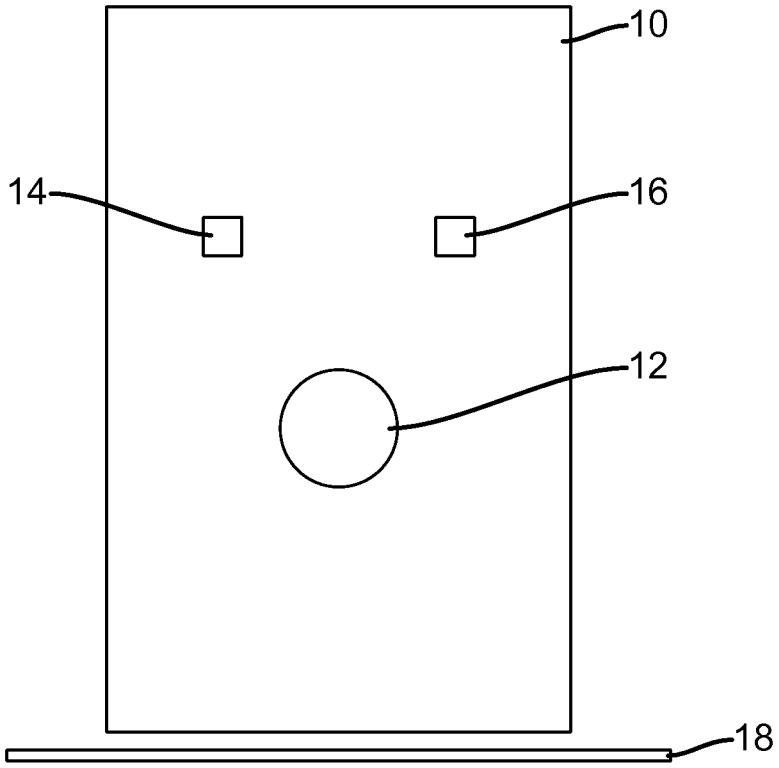

FIG. 1

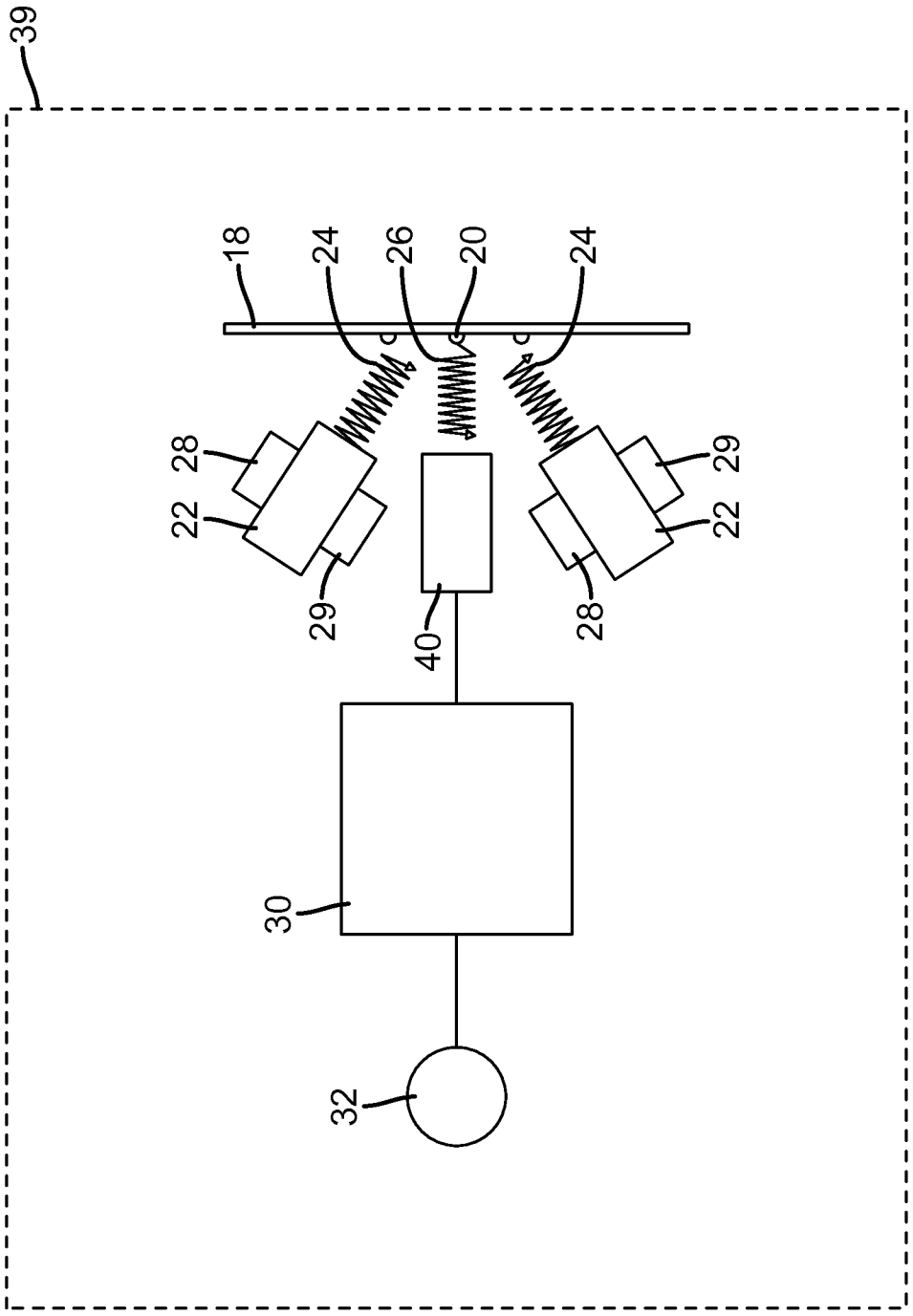

FIG. 2

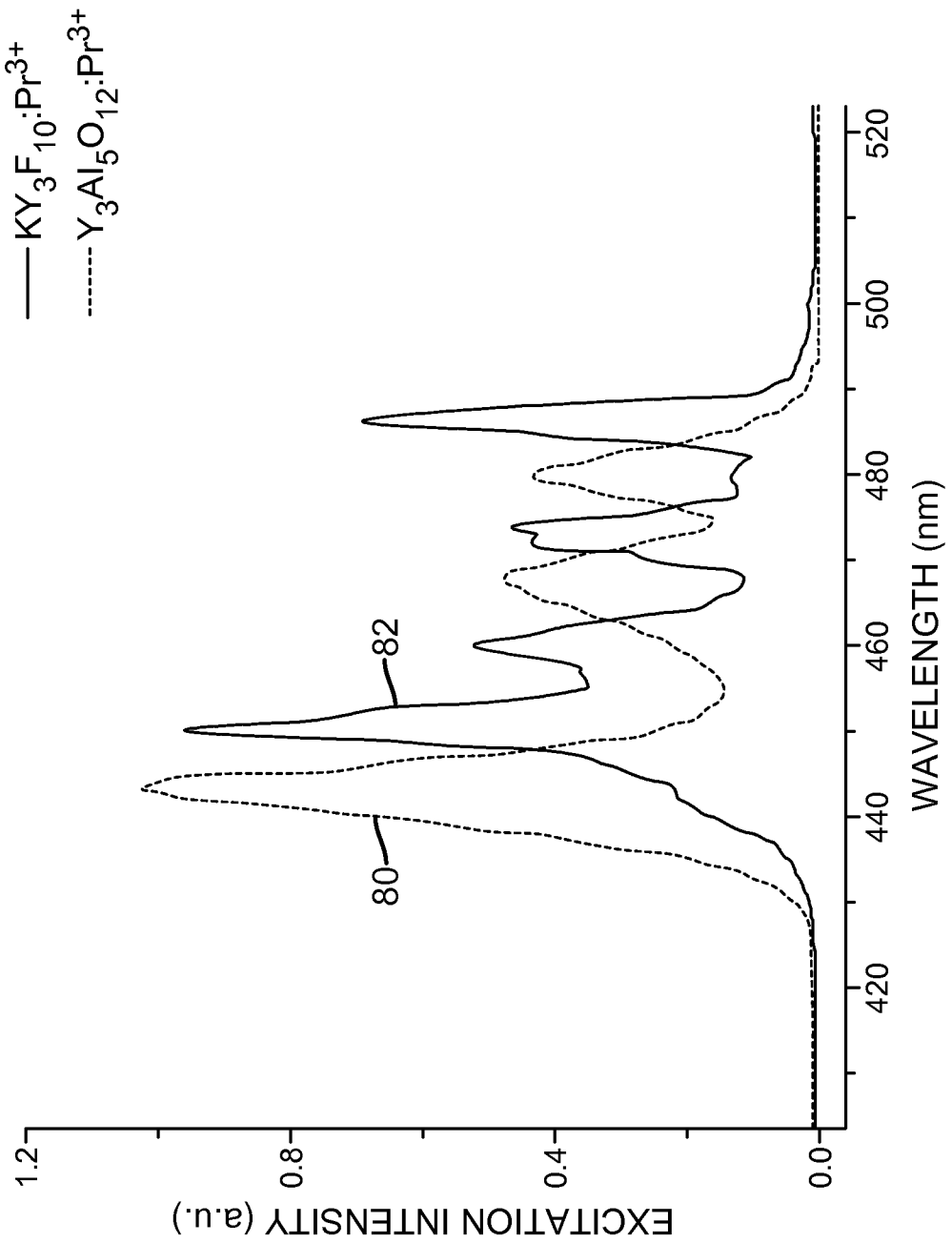
KY3F10:Pr3+
Y3Al5O12:Pr3+
EXCITATION INTENSITY (a.u.)
WAVELENGTH (nm)
0.0
0.4
0.8
1.2
420
440
460
480
500
520
80
82

FIG. 3

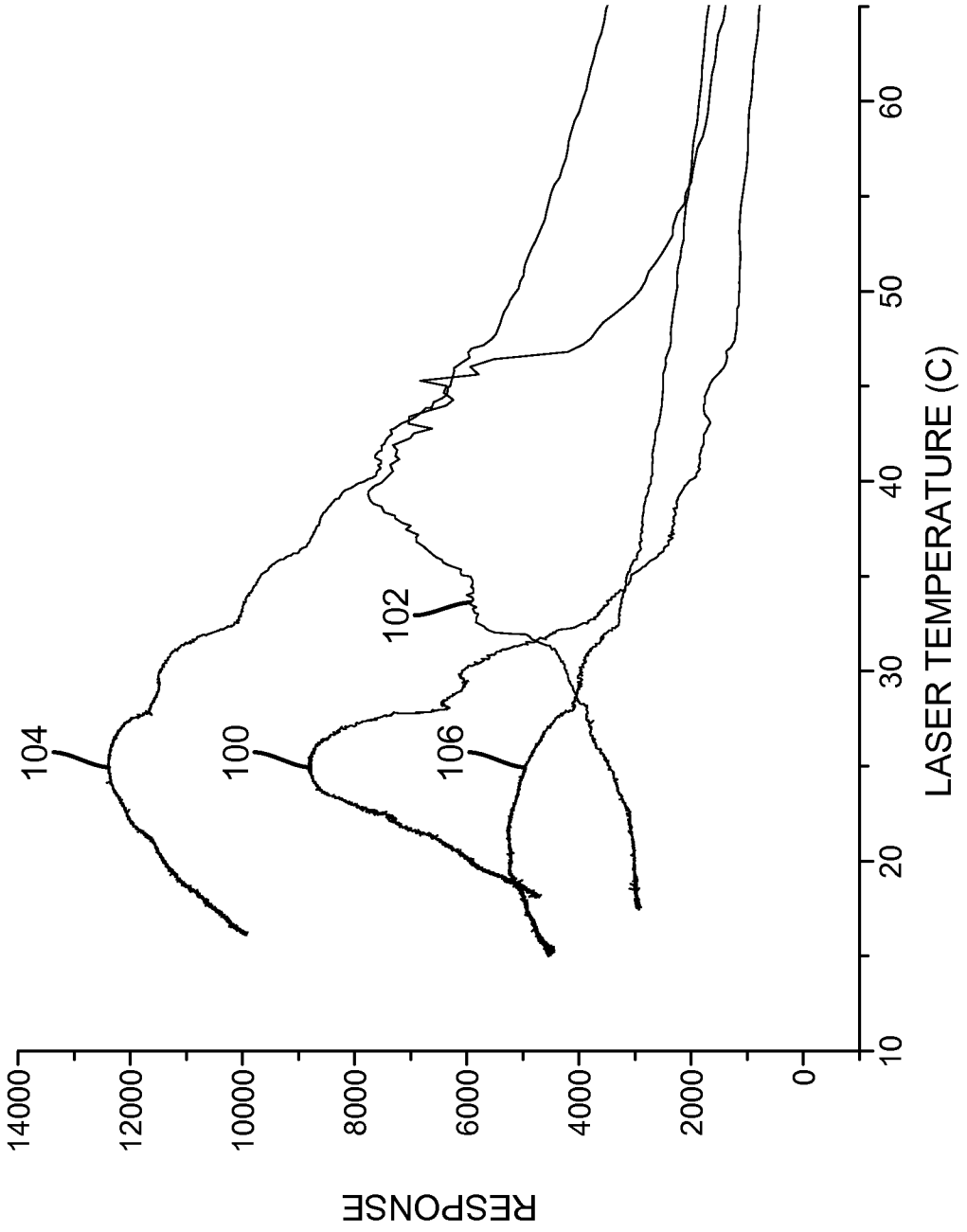
RESPONSE
14000
12000
10000
8000
6000
4000
2000
0
10
20
30
40
50
60
LASER TEMPERATURE (C)
104
100
102
106

FIG. 4

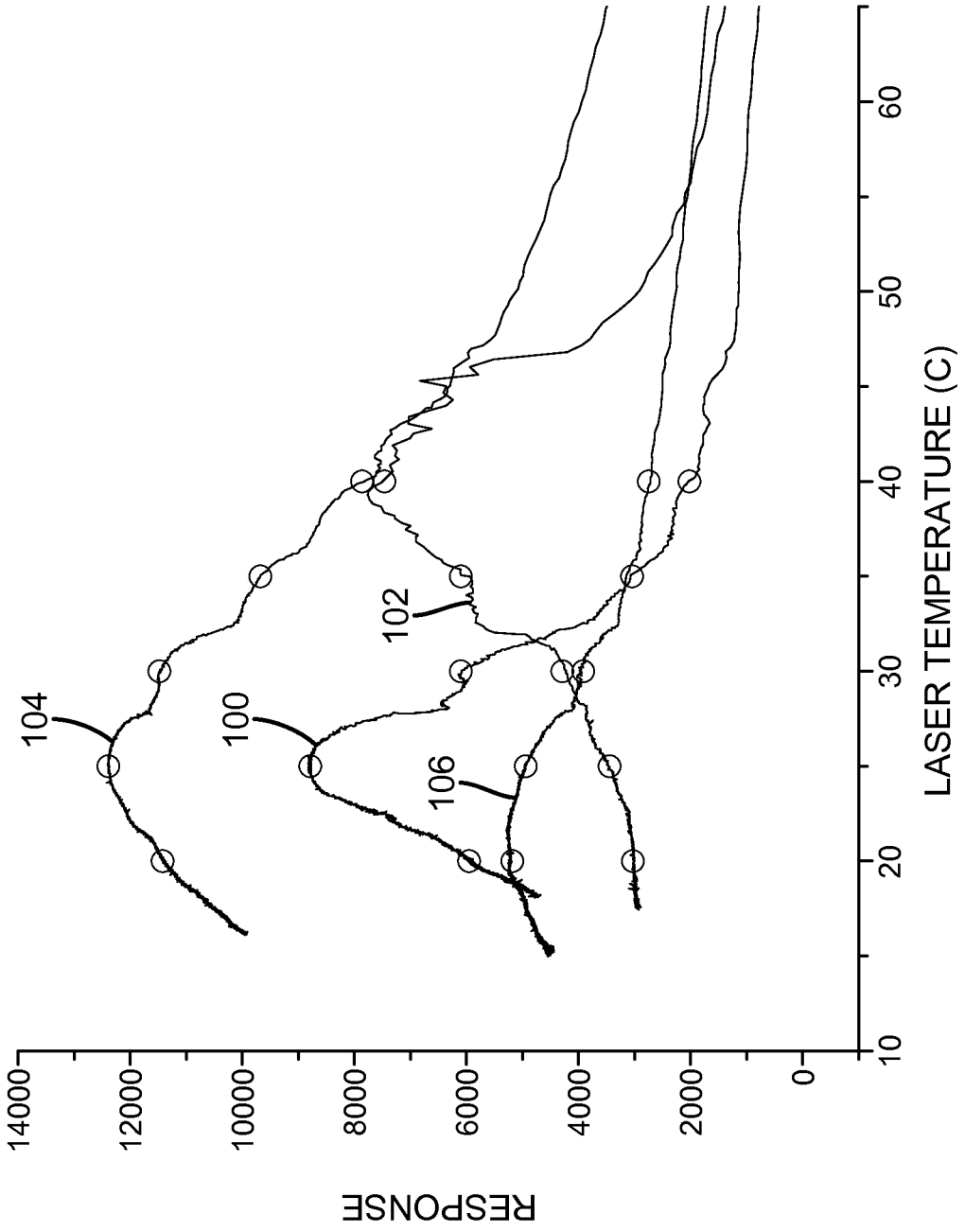
RESPONSE
14000
12000
10000
8000
6000
4000
2000
0
10
20
30
40
50
60
LASER TEMPERATURE (C)
104
100
102
106

FIG. 5

	a	b	c	d	e	f	g	h
Temperature (C)	Response Marker 100	Response Marker 102	Response unidentified marker	Normalized response Marker 100	Normalized response Marker 102	Normalized response unidentified marker	variance unidentified marker vs. marker 100	variance unidentified marker vs. marker 102
20	5996	3043	2322	0.68	0.40	0.42	-38%	3%
25	8849	3470	2652	1.00	0.46	0.48	-52%	4%
30	6105	4240	3238	0.69	0.56	0.58	-15%	4%
35	3168	6043	4518	0.36	0.80	0.81	128%	1%
40	1964	7514	5544	0.22	1.00	1.00	351%	0%
						mean variance:	108%	3%

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/040109

A. CLASSIFICATION OF SUBJECT MATTER
INV. G07D7/12
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	DE 10 2005 040821 A1 (GIESECKE & DEVRIENT GMBH [DE]) 8 March 2007 (2007-03-08) paragraphs [0011] - [0013], [0016], [0018] - [0021], [0024], [0031] - [0037] -----	1-5,7,8 6
Y A	US 2011/085157 A1 (BLOSS MICHAEL [DE] ET AL) 14 April 2011 (2011-04-14) paragraphs [0147], [0148] -----	6 1

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 July 2012	06/08/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Neville, David

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2012/040109

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102005040821 A1	08-03-2007	NONE	
US 2011085157 A1	14-04-2011	AU 2009259721 A1	23-12-2009
		CN 102124498 A	13-07-2011
		DE 102008028689 A1	24-12-2009
		EP 2304697 A1	06-04-2011
		US 2011085157 A1	14-04-2011
		WO 2009152961 A1	23-12-2009