UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/061,308	03/04/2016	Brandt Christopher Pein	MITX-771101US 317239-2275	2805

58249 7590 03/13/2017

COOLEY LLP
ATTN: Patent Group
1299 Pennsylvania Avenue, NW
Suite 700
Washington, DC 20004

EXAMINER	
VALENTINER, JEREMY SCOTT	

ART UNIT	PAPER NUMBER
2884	

NOTIFICATION DATE	DELIVERY MODE
03/13/2017	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

zpatdcdocketing@cooley.com

Office Action Summary	Application No. 15/061,308	Applicant(s) PEIN ET AL.	
	Examiner JEREMY S. VALENTINER	Art Unit 2884	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11/04/2016*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-17,19-25,27 and 28* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-17,19-25,27 and 28* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☒ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *03/04/2016* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *04/14/2016 & 11/01/2016*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Applicant: PEIN, Brandt Christopher; HWANG, Harold Young; CHANG, Wendi; NELSON, Keith A.; BULOVIC, Vladimir; & BRANDT, Nathaniel C.

Assignee: None indicated on the Application Data Sheet

Attorney: Christopher Colice (Reg. No.: 65,634)

Filing: Non-Provisional filed 04 March 2016

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Status of Claims

2. Claims 1-17, 19-25, and 27-28 are currently pending before the Office.

Priority

3. The instant application claims priority to Provisional Applications 62/129,105, 62/201,274, and 62/216,583 filed 06 March 2015, 05 August 2015, and 10 September 2015, respectively. While PCT/US16/20948 is a related application filed 04 March 2016.

Information Disclosure Statement

4. The information disclosure statements (IDSs) filed 04/14/2016 and 11/01/2016 have been considered to the extent possible. However, since it is unclear how each or the 39 non-patent literature documents and 1 foreign reference (totaling 390 pages) in the IDS dated 04/14/2016 are related to the claimed invention.

Drawings

5. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because reference character "**102**" has been used to designate both **visible light** and **visible radiation** in **Figure 1,** reference character "**212**" has been used to designate both **conductive strips** and **metal strips** in **Figures 2A-2D,** and reference character "**501**" has been used to designate both **scintillator** and **field-enhancing structure** in **Figure 5C**. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Specification

6. The disclosure is objected to because of the following informalities:

a. **Paragraph [0052]** – includes the phrase "emit visible light 102 . . . into visible radiation 102" which uses different reference names for the same reference numeral. The Applicants should pick one of "light", "radiation", or "light/radiation" to use consistent reference names with reference numeral **102**. Another choice would be to change the phrase to "emit visible ***radiation 102, e.g. visible light***, which".

b. **Paragraph [0053]** – includes the phrase "gap 115 (i.e., distance between 110a and 110b)" which should include a reference name for reference numerals **110a & 110b**, for instance "distance between ***portions*** 110a and 110b".

c. **Paragraphs [0064]-[0065] -** include the phrases "conductive strips 212 . . . the metal strips 212 . . . multiple conductive strips 212 . . . width of the metal strips 212)" which uses

different reference names for the same reference numeral. The Applicants should pick one consistent reference name for reference numeral **212**.

d. **Paragraph [0076]** – includes the phrase "a scintillator 501 . . . The scintillator 501 also . . . the field-enhancing structure 501" which uses different reference names for the same reference numeral **501**. The phrase "field-enhancing structure 501" should probably be changed to "the ***scintillator*** 501", or "field-enhancing structure" should be given a different reference numeral.

Appropriate correction is required.

7. The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification and/or errors in the drawings due to inconsistent use of reference numerals or reference names.

Claim Objections

8. Claims 11-12 are objected to because of the following informalities: the abbreviation "Alq_3" must be defined in the claims since they are not dependent on one another and have not been previously defined in a common parent claim. Appropriate correction is required.

Claim Rejections - 35 USC § 112

9. The following is a quotation of 35 U.S.C. 112(b):

> (b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

10. Claims 1-17, 19-25, and 27-28 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claims 1, 19, and 20 include the phrase “detecting radiation including at least one spectral component having a frequency having a frequency range of about 100 GHz to about 100 THz” which is indefinite because it is unclear how to interpret the phrases “at least one” and “spectral component” together since they appear to be mutually exclusive. It is unclear if the claimed invention requires the detection of "***only one*** spectral component", since "at least one" makes it open-ended to the point that any detector detecting one frequency, multiple frequencies, or the entire range between 100 GHz and 100 THz would correspond to the claimed invention. Furthermore, **Figures 2A-2B & 5A-5B** disclose detecting the “polarization direction of the incident radiation" (**Spec., ¶[0067]**) and “Diagonally or elliptically polarized radiation produces enhanced fields in all four gaps **515**. Therefore, one split ring resonator **510** can detect incident radiation of arbitrary polarization” (**Spec., ¶[0072]**), which makes it unclear if the “at least one spectral component” includes detecting polarization in “one direction", e.g. **Figs. 2A-2B**, or in "multiple directions”, e.g. **Figs. 5A-5B**. The claims must be amended to clarify if the detector is a “single wavelength detector” – to the exclusion of all other wavelengths, capable of detecting multiple “single wavelengths” simultaneously, if the “spectral component” is at one polarization direction or multiple polarization directions, or otherwise clarify the relationship of “at least one”, “spectral component”, and polarization direction.

Claims 1-17 and 19 include the phrase "at least one conductive structure defining at least one gap" however it is unclear if the "gap" is defined by multiple conductive structures, a single conductive structure defining a "gap" - i.e. a ring or trench within a solid structure, or other unnamed structure since the apparatus includes the “comprising” transitional phrase and since the claims only require “at least one conductive structure”. Further detail should be added to define how the "at least one conductive structure" could form the "at least one gap".

Claim 19 includes the phrase an “***apparatus*** . . . comprising . . . a light source . . ***. to illuminate*** the EL material” which is indefinite for claiming both an apparatus and the method steps of using the apparatus (**see MPEP §2173.05(p), *In re Katz Interactive Call Processing Patent Litigation,* 639 F.3d 1303, 97 USPQ2d 1737 (Fed. Cir. 2011). In *Katz*, a claim directed to “[a] system with an interface means for providing automated voice messages…to certain of said individual callers, wherein**

said certain of said individual callers digitally enter data" was determined to be indefinite because the italicized claim limitation is not directed to the system, but rather to actions of the individual callers, which creates confusion as to when direct infringement occurs. *Katz*, 639 F.3d at 1318 (citing *IPXL Holdings v. Amazon.com, Inc.*, 430 F.3d 1377, 1384, 77 USPQ2d 1140, 1145 (Fed. Cir. 2005), in which a system claim that recited "an input means" and required a user to use the input means was found to be indefinite because it was unclear "whether infringement ... occurs when one creates a system that allows the user [to use the input means], or whether infringement occurs when the user actually uses the input means."); *Ex parte Lyell, 17 USPQ2d 1548 (Bd. Pat. App. & Inter. 1990)*). The claims should be amended to claim structure "configured" or "arranged" to perform functions, rather than claiming structure performing a step, e.g. "system is configured to adjust". The claim should be written in a manner to clarify the structure configured to cause the intended result.

Claim 20 includes the phrase "method of detecting electromagnetic radiation . . . receiving the electromagnetic radiation . . . generating an enhanced electric field . . . emitting light from an electroluminescent (EL) material . . . detecting the light emitted by the EL material; and illuminating the EL material with a light beam" which is unclear for multiple reasons. Firstly, it is unclear if the method requires a person, a computer processing system, or other subject to facilitate the "receiving", "generating", "emitting light from an electroluminescent (EL) material", "detecting", and/or "illuminating the EL material" since it is indefinite whether the method steps are a consequence of "receiving the electromagnetic radiation" or if steps need to be taken by a subject/computer/etc. to perform the "generating", "emitting", "detecting", and/or "illuminating". Secondly, it is unclear when the "illuminating the EL material" step is to be performed. One logical conclusion would be that the "illuminating" step occurs after the "light emitted by the EL material" has been "detect[ed]". Another conclusion would be that the "illuminating" step needs to occur contemporaneously with all of the other method steps, after the "receiving the electromagnetic radiation step", or at some other time during the method. Further limitations need to be added to the claims to clarify if the method needs to be performed by an apparatus performing the method, by a person controlling an apparatus, to clarify the source of "emitting light from an EL material", and when the "illuminating" step needs to be peformed.

Claim Rejections - 35 USC § 103

11. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

12. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

13. This application currently names joint inventors. In considering patentability of the claims the examiner presumes that the subject matter of the various claims was commonly owned as of the effective filing date of the claimed invention(s) absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and effective filing dates of each claim that was not commonly owned as of the effective filing date of the later invention in order for the examiner to consider the applicability of 35 U.S.C. 102(b)(2)(C) for any potential 35 U.S.C. 102(a)(2) prior art against the later invention.

14. Claims 1, 5, 9-10, and 13-16 is/are rejected under 35 U.S.C. 103 as being unpatentable over **Bergeron (US Pub. 2013/0341529)** and **Rapaport (US Pub. 2013/0134309)**.

Regarding claim 1, **Bergeron** discloses an apparatus for detecting electromagnetic radiation including at least one spectral component having a frequency within a range of about 100 GHz to about 100 THz (**Bergeron: Figs. 3-7; Abstract - detecting high-power microwave radiation is provided . . . electroluminescence material disposed on the portion; ¶¶2-3 invention relates generally to conversion of incident microwave radiation to visible light. In particular, the invention uses electroluminescence to receive and detect microwave radiation and in response emit photons in the visible portion of the electromagnetic spectrum . . . Microwaves, broadly including ultra-high**

frequency (UHF) and extreme-high frequency (EHF) can be defined as electromagnetic radiation with wavelengths λ of approximately between 1 m and 1 mm (10^{-3} m), which correspond to frequencies v=c/λ between 0.3 GHz (10^{9} Hz) and 0.3 THz (10^{12} Hz).; ¶¶22-25; ¶¶37-43; ¶¶62-71), the apparatus comprising:

- at least one conductive structure defining at least one gap to receive the electromagnetic radiation and generate an enhanced electric field in response to the at least one spectral component (**Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71**); and
- an electroluminescent (EL) material disposed at least partially within the at least one gap to emit light in response to the enhanced electric field (**Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71**).

However, **Bergeron** fails to disclose a silicon oxide layer.

In a related field of endeavor, **Rapaport** discloses an apparatus for detecting electromagnetic radiation including at least one spectral component having a frequency within an infrared range (**Rapaport: Figs. 1, 3-4, & 11; Abstract - invention provides detectors and imaging systems based on devices and methods of this invention; ¶¶91-98 In one embodiment, the irradiated electromagnetic radiation is in the IR range . . . the emitted electromagnetic radiation (emitted form devices of the invention) is in the near IR range**), the apparatus comprising:

- at least one conductive structure defining at least one gap to receive the electromagnetic radiation and generate an enhanced electric field in response to the at least one spectral component (**Figs. 1, 3-4, & 11; Abstract; ¶¶91-98 grating comprises metal. . . . In one embodiment, the metal is any metal that can be used to form the grating. . . . In one embodiment, the coating of the metallic grating comprises quantum dots or quantum dots embedded in a polymer. In one embodiment, the grating is coated by a mixture of quantum dots and non linear material.**);
- an electroluminescent (EL) material disposed at least partially within the at least one gap to emit light in response to the enhanced electric field (**Figs. 1, 3-4, & 11; Abstract; ¶¶48-51 a nanoslit array (NSA) structure depicted in the center consists of a dielectric polymer layer with nanocrystal**

quantum dots (NQD's) (marked by circles) on top of an aluminum (Al) grating.; ¶¶73-74; ¶¶91-98; ¶¶178-186; ¶¶189-196); and

- a silicon oxide layer, disposed between the at least one conductive structure and the EL material, to electrically insulate the at least one conductive structure from the EL material (**Figs. 1, 3-4, & 11; Abstract; ¶7 dielectric layers comprise GaAs, AlGaAs, Si, silicon dioxide, Quartz, Ge, GaN, GaAlN, InGaAs, InGaP or a combination thereof.; ¶¶48-54; ¶75 the dielectric material of this invention is positioned as one or more layers on top of the grating, below the grating or on top and below the grating. In one embodiment, the layers comprise dielectric materials. In one embodiment, the dielectric materials include non limiting examples of GaAs, AlGaAs, silicon, silicon dioxide, Quartz, Ge, GaN, GaAlN, InGaAs or InGaP; ¶78; ¶81; ¶91 quantum dots embedded in a polymer; ; ¶¶189-196 NQD are evenly dispersed in the polymer layer on the metallic grating; claims 2 & 12**).

In view of the ability to enhance the electromagnetic field through the arrangement of conductive structures, electroluminescent material, and a dielectric silicon dioxide layer which enhances nonlinear phenomenon within the dielectric layer as is disclosed in **Rapaport** at **Paragraphs 5-21**, it would have been obvious before the effective filing date of the claimed invention to combine the teachings of **Rapaport** with the teachings of **Bergeron** to obtain enhancement in the optical signal and electric signal generated in the combination.

Regarding claim 5, **Bergeron** further discloses wherein the at least one conductive structure comprises at least two conductive strips and the at least one gap comprises at least one micro-slit defined by the at least two conductive strips, the at least one micro-slit having a width of about 0.1 μm to about 10 μm (**Bergeron: Figs. 3-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43 conductor has a minimum distance or length corresponding to an electron path distance 550, and can range from hundreds of nanometers to several micrometers. The minimum distance refers to the minimum thickness of the layered conductor required to accelerate the electrons to energies sufficient to induce luminescence; ¶¶62-71**).

Regarding claim 9, **Bergeron** and **Rapaport** further disclose wherein the EL material is configured to emit visible light (**Bergeron: ¶¶23-25; ¶35; ¶¶65-77; ¶85; Rapaport: ¶¶14-16; ¶19; ¶26; ¶33; ¶58; ¶¶93-96; ¶109; ¶¶119-123**).

Regarding claim 10, **Rapaport** further discloses wherein the EL material is configured to emit infrared light (**Rapaport: ¶¶91-98 In one embodiment, the irradiated electromagnetic radiation is broad-band. In one embodiment, the emitted electromagnetic radiation (emitted form devices of the invention) is in the near IR range; ¶109; ¶¶171-173; ¶178; ¶196**).

Regarding claim 13, **Rapaport** further discloses wherein the EL material comprises at least one quantum dot (**Rapaport: ¶48; ¶¶178-183; ¶¶192-196**).

Regarding claim 14, **Bergeron** further discloses the apparatus further comprising a detector, in optical communication with the EL material, to detect the light emitted by the EL material (**Bergeron: Fig. 3; Fig. 4 photodetector 420 EL phosphor 450; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43 FIG. 4 shows a block diagram view 400 . . . and a photodetector 420; ¶¶62-71**).

Regarding claim 15, **Rapaport** further discloses wherein the detector comprises at least one of an avalanche photodiode and an intensified charge-coupled-device (**Rapaport: ¶¶22-39 avalanche photodetector; ¶¶138-169**).

Regarding claim 16, **Bergeron** and **Rapaport** further disclose wherein the at least one conductive structure is disposed on the detector (**Bergeron: Fig. 3; Fig. 4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71; Rapaport: Figs. 1, 3-4, & 11; Abstract; ¶7; ¶¶48-54; ¶75; ¶78; ¶81; ¶¶91-98; ; ¶¶189-196**).

15. Claims 2-4 and 6-8 is/are rejected under 35 U.S.C. 103 as being unpatentable over **Bergeron (US Pub. 2013/0341529)** and **Rapaport (US Pub. 2013/0134309)** as applied to claims 1 and 5, respectively, above, and further in view of **Hwang et al. (US Pub. 2014/0061469)**.

Regarding claim 2, **Bergeron** and **Rapaport** disclose the apparatus of claim 1, but are silent regarding a split ring resonator.

In a related field of endeavor, **Hwang et al.** discloses an apparatus for detecting electromagnetic radiation including at least one spectral component having a frequency within a range of about 100 GHz to about 100 THz (**Hwang et al.: Figs. 1-3; Figs. 15A-15B; Abstract; ¶¶7-19 any of the apparatus described herein, the target frequency range can range from about 100 GHz to about 100 THz.**), the apparatus comprising: at least one conductive structure and a dielectric material, wherein the at least one conductive structure comprises at least one split ring resonator (**Figs. 1-3; Figs. 15A-15B; Abstract; ¶¶7-19; ¶36 detectors, image sensors, or other devices or systems according to principles herein, each of the one or more resonator structures can be formed as a split-ring resonator structure, where each split-ring resonator structure includes at least two spacings formed between corresponding pairs of the at least two conductive structures; ¶¶68-69; ¶100; ¶115; ¶119; ¶196**).

In view of the ability to obtain fast and sensitive detection in security situations using split-ring resonator structures as is disclosed in **Hwang et al.** at **Paragraphs 7-19, 96, & 206**, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to combine the teachings of **Hwang et al.** with the teachings of **Bergeron** and **Rapaport** to obtain fast and sensitive detection in the 100 GHz to 100 THz range.

Regarding claim 3, **Hwang et al.** further discloses wherein the at least one split ring resonator comprises a first split ring resonator having a first resonant frequency and a second split ring resonator having a second resonant frequency different than the first resonant frequency (**Hwang et al.: Figs. 1-3; Figs. 15A-15B; Abstract; ¶¶7-19; ¶31 at least two conductive structures from another of the at least two conductive structures in the z-direction, and where the target electromagnetic radiation is of a frequency within the target frequency range. . . . at least four conductive structures can have a first length that targets electromagnetic radiation of a first frequency within the target frequency range, . . . where the second pair of the at least four conductive structures targets electromagnetic radiation of a second frequency within the target frequency range. . . . The second frequency is greater than the first frequency; ¶36; ¶¶68-69; ¶100; ¶115; ¶119; ¶¶181-203**).

Regarding claim 4, **Hwang et al.** further discloses wherein the first resonant frequency and the second resonant frequency are with the range of about 100 GHz to about 100 THz (**Hwang et al.: Figs. 1-3; Figs. 15A-15B; Abstract; ¶¶7-19; ¶31; ¶36; ¶¶68-69; ¶100; ¶115; ¶119; ¶¶181-203**).

Regarding claim 6, **Bergeron** and **Hwang et al.** further disclose wherein a first conductive strip in the at least two conductive strips is electrically coupled to a first electrode and a second conductive strip in the at least two conductive strips is electrically coupled to a second electrode to generate a direct current (DC) electric field across the at least one micro-slit (**Bergeron: Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶35 Rectennas directly convert microwave energy into DC electricity and can be optimized for low power microwave/RF wavelengths. Rectennas are commonly used as the receiving component of RFID systems. As the rectenna is capable of harvesting RF energy and producing DC electricity at power levels many orders of magnitude below HPM systems, electroluminescence could be produced for a variety of applications.; ¶¶37-43; ¶¶62-71 while in a direct current (DC) ELD, one material remains the cathode, or electron emitter, and the other is the anode.; Hwang et al.: Figs. 1-3; Figs. 15A-15B; Abstract; ¶¶7-19; ¶¶25-31 apparatus can be configured such that charge carriers are generated in a region of the substrate near the spacing based on an enhanced electric field induced in the spacing by a resonant response of the resonator structure to a presence of the target electromagnetic radiation having the different polarizations. The apparatus can be configured to measure the conductivity based on the generated charge carriers as an indication of a presence of the target electromagnetic radiation, and the measure of the conductivity can be a voltage measurement or a current measurement; ¶36; ¶¶68-69; ¶80 apparatus and method herein exploit the measurable changes in the conductivity (i.e., current and/or voltage) in a device according to principles herein for detecting or otherwise quantifying electromagnetic radiation at frequencies in the detection range.; ¶¶82-86; ¶100; ¶106; ¶¶109-112; ¶¶114-115; ¶119; ¶¶122-123; ¶131; ¶146 peak surface current may be localized to the equivalent dipole structures for frequencies above about one THz, whereas for frequencies lower than about one THz, the peak**

surface current may be largely localized to the connected bar (such as conductive structures 714 *c* and 716 *c*); ¶157; ¶¶181-203).

Regarding claim 7, **Hwang et al.** further discloses wherein the at least one micro-slit comprises a plurality of micro-slits defined by a plurality of interdigitated conductive strips (**Hwang et al.: Figs. 1-3; Figs. 15A-15B; Abstract; ¶¶7-19 one or more resonator structures can be arranged in an alternating interdigitated arrangement; ¶¶25-31; ¶¶36-37; ¶56; ¶¶68-69; ¶80; ¶¶82-86; ¶100; ¶106; ¶¶109-112; ¶¶114-115; ¶119; ¶¶122-123; ¶131; ¶¶145-147 gap 719 between the equivalent "dipole" portion and the resonator structure in the spacing can be about one 1.0 micron. In another examples, the gap can be less than about 1.0 microns (μm) or greater than about 1.0 microns (μm); ¶157; ¶¶181-203**).

Regarding claim 8, **Bergeron** and **Hwang et al.** further disclose wherein a first plurality of conductive strips in the plurality of interdigitated conductive strips is electrically coupled to a first electrode and a second plurality of conductive strips in the plurality of interdigitated conductive strips is electrically coupled to a second electrode so as to generate a direct current (DC) electric field in the plurality of micro-slits (**Bergeron: Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶35; ¶¶37-43; ¶¶62-71; Hwang et al.: Figs. 1-3; Figs. 15A-15B; Abstract; ¶¶7-19; ¶¶25-31; ¶¶36-37; ¶56; ¶¶68-69; ¶80; ¶¶82-86; ¶100; ¶106; ¶¶109-112; ¶¶114-115; ¶119; ¶¶122-123; ¶131; ¶¶145-147; ¶157; ¶¶181-203**).

16. Claims 11-12 is/are rejected under 35 U.S.C. 103 as being unpatentable over **Bergeron (US Pub. 2013/0341529)** and **Rapaport (US Pub. 2013/0134309)** as applied to claim 1 above, and further in view of **Morita et al. (US Pub. 2014/0008642)**.

Regarding claim 11, **Bergeron** and **Rapaport** disclose the apparatus of claim 1, but are silent regarding Alq_3.

In a related field of endeavor, **Morita et al.** discloses an electroluminescent material (**Morita et al.: Figs. 1-4; Abstract - a low molecular weight luminescent material; ¶¶7-10; ¶¶50-52**), comprising: the electroluminescent (EL) material having a low molecular weight wherein the EL material comprises

Alq_3 (**Figs. 1-4; ¶¶7-10; ¶¶50-52 organic luminescent layer 8 emitting red light include tris(8-quinolinol) aluminum (Alq_3) as a host material having DCM (4-dicyanomethylene-6-(p-dimethylaminostyryl)-2-methyl-4H-pyran) and DCJTB (4-dicyanomethylene-6-(p-dimethylaminostyryl)-2-(t-butyl)-4H-pyran, which are pyran compounds as dopants, added thereto in a doping concentration of 2%, respectively. The low molecular weight luminescent material**).

In view of the ability to obtain a low molecular weight luminescent material as is disclosed in **Morita et al.** at **Paragraphs 7-10 & 50-52**, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to combine the teachings of **Morita et al.** with the teachings of **Bergeron** and **Rapaport** to a low molecular weight luminescent material.

Regarding claim 12, **Morita et al.** further discloses wherein the EL material comprises Alq_3 doped with 4-(dicyanomethylene)-2-methyl-6-(p-dimethylaminostyryl)-4H-pyran (**Morita et al.: Figs. 1-4; ¶¶7-10; ¶¶50-52**).

17. Claim 17 is/are rejected under 35 U.S.C. 103 as being unpatentable over **Bergeron (US Pub. 2013/0341529)** and **Rapaport (US Pub. 2013/0134309)** as applied to claim 14 above, and further in view of **Paeschke et al. (WO 2014/067922 published 08 May 2014 corresponding to US Pub. 2015/0294177 referred to below for convenience)**.

Regarding claim 17, **Bergeron** and **Rapaport** discloses the apparatus of claim 14, but are silent regarding a relay optic.

In a related field of endeavor, **Paeschke et al.** discloses an apparatus for detecting electromagnetic radiation including at least one spectral component having a frequency within an infrared range (**Paeschke et al.: Fig. 1 apparatus 1 CCD chip 3 evaluation device 4 lens 5 1st source 8 2nd source 9; Abstract; ¶¶9-14 substances having electroluminescent properties . . . The substances used emit after excitation in an alternating electric field primarily electromagnetic radiation in the visible range, with emission in the ultraviolet or infrared spectral range also being possible, however. . . . particulate electroluminescent substances are used alone or in a mixture of two or**

more different ones. If different substances are used, it is advantageous if they emit radiation of different colors; ¶22 electric excitation field can have a predetermined frequency and is used for excitation of the electroluminescent pigments, whereby they emit corresponding luminescence light or radiation.), comprising: an electroluminescent (EL) material, a field suppression element, and a detector to detect light emitted by the EL material (**Fig. 1 apparatus 1 CCD chip 3 evaluation device 4 lens 5 1st source 8 2nd source 9; Abstract; ¶¶9-14; ¶22**), wherein the apparatus further comprises a relay optic, in optical communication with the EL material and the detector, to transmit the light emitted by the EL material onto the detector (**Fig. 1 apparatus 1 CCD chip 3 evaluation device 4 lens 5 1st source 8 2nd source 9; Abstract; ¶¶9-14; ¶22; ¶78; ¶¶86-88**).

In view of the ability to use optical elements, e.g. lenses or other elements, to generate an optical image from electroluminescent material as is disclosed in **Paeschke et al.** at **Paragraphs 22, 78, & 86-88**, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to combine the teachings of **Paeschke et al.** with the teachings of **Bergeron** and **Rapaport** to assist in image formation of emission from electroluminescent material and obtain a desired resolution.

18. Claims 19-22 and 24 is/are rejected under 35 U.S.C. 103 as being unpatentable over **Bergeron (US Pub. 2013/0341529)** and **Szeles et al. (US Pub. 2010/0078559)**.

Regarding claim 19, **Bergeron** discloses an apparatus for detecting electromagnetic radiation including at least one spectral component having a frequency within a range of about 100 GHz to about 100 THz (**Bergeron: Figs. 3-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71**), the apparatus comprising:

- at least one conductive structure defining at least one gap to receive the electromagnetic radiation and generate an enhanced electric field in response to the at least one spectral component (**Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71**); and

- an electroluminescent (EL) material disposed at least partially within the at least one gap to emit light in response to the enhanced electric field (**Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71**).

However, **Bergeron** fails to disclose illuminating the EL material with a light source.

In a related field of endeavor, **Szeles et al.** further discloses an apparatus for detecting electromagnetic radiation including at least one spectral component, the apparatus (**Szeles et al.: Figs. 1-7; Abstract - method of detecting radiation through which the residence time of charge carriers is dramatically reduced by an external optical energy source and the occupancy of the deep-level defects is maintained close to the thermal equilibrium of the un-irradiated device even under high-flux exposure conditions; ¶¶14-16; ¶¶32-35**) comprising: at least one conductive structure, an electromagnetic radiation detecting material, and a light source (**Figs. 1-7; Abstract; ¶¶14-16; ¶¶32-35**), in optical communication with the material, to illuminate the material with a beam of light having a photon energy below a band gap of the material so as to increase a sensitivity of the apparatus to the at least one spectral component (**Figs. 1-7; Abstract; ¶¶14-16 infra-red light radiation is used to provide sufficient energy for the trapped carriers to escape from the defect levels. The energy of the infra-red light source is tuned to the (0.6-0.8) eV range corresponding to the ionization energy of the deep-level defects in the middle of the band gap. The $Cd_{1-x}Zn_xTe$ crystals are transparent to infra-red light of this energy and no additional absorption occurs other than the one associated with the ionization of the targeted deep-level defects; ¶¶32-35 FIG. 3 shows that the residence time of carriers 9 as a function of the thermal ionization energy (energy difference to the edge of the band gap) of the various defect levels 6, 7, and 8. The long time scale associated with emptying of the deep-level defects 8**). In view of the ability to remove deep level defects in a material and overcome energy differences to the edge of a band gap as is disclosed in **Szeles et al.** at **Paragraphs 14-16 & 32-35**, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to combine the teachings of **Szeles et al.** with the teachings of **Bergeron** to remove deep level defects in a material using a light source. The combination discloses the claimed invention except for illuminating an electroluminescent material with a light source. However, in view of the fact that

Szeles et al. discloses that it is known in the art to provide a light source to overcome an energy difference to the edge of a band gap in semiconductor materials as disclosed in **Figures 1 & 4-6** and **Paragraphs 32-35**. It would have been obvious to one of ordinary skill in the art before the effective filing date of the invention to provide a light source to illuminate electroluminescent material with a beam of light to remove energy differences to the edge of the band gap according to the teachings of **Szeles et al.** in order to obtain increased efficiency in an electroluminescent material.

Regarding claim 20, **Bergeron** discloses a method of detecting electromagnetic radiation including at least one spectral component having a frequency within a range of about 100 GHz to about 100 THz (**Bergeron: Figs. 3-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71**), the method comprising:

- receiving the electromagnetic radiation at a field-enhancing structure (FES) (**Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71**);
- generating an enhanced electric field at the FES in response to the at least one spectral component (**Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71**);
- emitting light from an electroluminescent (EL) material electromagnetically coupled to the FES in response to the enhanced electric field (**Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71**); and
- detecting the light emitted by the EL material (**Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71**).

However, **Bergeron** fails to disclose illuminating the EL material with a light source.

In a related field of endeavor, **Szeles et al.** further discloses a method for detecting electromagnetic radiation including at least one spectral component, the apparatus (**Szeles et al.: Figs. 1-7; Abstract; ¶¶14-16; ¶¶32-35**) comprising: receiving the electromagnetic radiation at a radiation detecting material, and illuminating the radiation detecting material with a light source (**Figs. 1-7; Abstract; ¶¶14-16; ¶¶32-35**), wherein the illuminating step further includes illuminating the material with

a beam of light having a photon energy below a band gap of the material so as to increase a sensitivity of the apparatus (**Figs. 1-7; Abstract; ¶¶14-16; ¶¶32-35**). In view of the ability to remove deep level defects in a material and overcome energy differences to the edge of a band gap as is disclosed in **Szeles et al.** at **Paragraphs 14-16 & 32-35**, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to combine the teachings of **Szeles et al.** with the teachings of **Bergeron** to remove deep level defects in a material using a light source. The combination discloses the claimed invention except for illuminating an electroluminescent material with a light source. However, in view of the fact that **Szeles et al.** discloses that it is known in the art to provide a light source to overcome an energy difference to the edge of a band gap in semiconductor materials as disclosed in **Figures 1 & 4-6** and **Paragraphs 32-35**. It would have been obvious to one of ordinary skill in the art before the effective filing date of the invention to provide a light source to illuminate electroluminescent material with a beam of light to remove energy differences to the edge of the band gap of the EL material so as to increase a sensitivity of the field-enhancing structure according to the teachings of **Bergeron** and **Szeles et al.** in order to obtain increased efficiency in an electroluminescent material.

Regarding claim 21, **Bergeron** further discloses wherein receiving the electromagnetic radiation at the FES comprises receiving the electromagnetic radiation at a micro-slit defined by at least two conductive strips (**Bergeron: Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71**).

Regarding claim 22, **Bergeron** further discloses applying a direct current (DC) electric field across the micro-slit to increase a sensitivity of the apparatus (**Bergeron: Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶35 Rectennas directly convert microwave energy into DC electricity and can be optimized for low power microwave/RF wavelengths. Rectennas are commonly used as the receiving component of RFID systems. As the rectenna is capable of harvesting RF energy and producing DC electricity at power levels many orders of magnitude below HPM systems, electroluminescence could be**

produced for a variety of applications.; ¶¶37-43; ¶¶62-71 while in a direct current (DC) ELD, one material remains the cathode, or electron emitter, and the other is the anode.).

Regarding claim 24, **Bergeron** further discloses wherein emitting the light from the EL material comprises emitting visible light (**Bergeron: Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25 electroluminescence process to generate visible luminescence from microwave radiation; ¶¶37-43; ¶¶62-71**).

19. Claims 23 and 27 is/are rejected under 35 U.S.C. 103 as being unpatentable over **Bergeron (US Pub. 2013/0341529)** and **Szeles et al. (US Pub. 2010/0078559)** as applied to claim 20 above, and further in view of **Hwang et al. (US Pub. 2014/0061469)**.

Regarding claim 23, **Bergeron** and **Szeles et al.** disclose the method of claim 20, but are silent regarding a split ring resonator.

In a related field of endeavor, **Hwang et al.** discloses a method for detecting electromagnetic radiation including at least one spectral component having a frequency within a range of about 100 GHz to about 100 THz (**Hwang et al.: Figs. 1-3; Figs. 15A-15B; Abstract; ¶¶7-19 any of the apparatus described herein, the target frequency range can range from about 100 GHz to about 100 THz.**), the method comprising: receiving electromagnetic radiation at a field-enhancing structure (FES) and a dielectric material, wherein receiving the electromagnetic radiation at the FES comprises receiving the electromagnetic radiation at a split ring resonator. (**Figs. 1-3; Figs. 15A-15B; Abstract; ¶¶7-19; ¶36; ¶¶68-69; ¶100; ¶115; ¶119; ¶196**).

In view of the ability to obtain fast and sensitive detection in security situations using split-ring resonator structures as is disclosed in **Hwang et al.** at **Paragraphs 7-19, 96, & 206**, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to combine the teachings of **Hwang et al.** with the teachings of **Bergeron** and **Rapaport** to obtain fast and sensitive detection in the 100 GHz to 100 THz range.

Regarding claim 27, **Bergeron** and **Hwang et al.** further disclose wherein the FES is deposited on a detector and wherein detecting the light comprises detecting the light with the detector (**Bergeron: Figs. 3-4; Fig. 5 insulating substrate 510 conductor 520 phosphor 530; Figs. 6-7; Abstract; ¶¶2-3; ¶¶22-25; ¶¶37-43; ¶¶62-71; Hwang et al.: Figs. 1-3; Figs. 15A-15B; Abstract; ¶¶7-19; ¶36; ¶¶68-69; ¶100; ¶115; ¶119; ¶196**).

20. Claim 25 is/are rejected under 35 U.S.C. 103 as being unpatentable over **Bergeron (US Pub. 2013/0341529)** and **Szeles et al. (US Pub. 2010/0078559)** as applied to claim 20 above, and further in view of **Rapaport (US Pub. 2013/0134309)**.

Regarding claim 25, **Bergeron** and **Szeles et al.** disclose the method of claim 20, but are silent regarding the EL material emitting infrared light.

In a related field of endeavor, **Rapaport** discloses a method for detecting electromagnetic radiation including at least one spectral component having a frequency within an infrared range (**Rapaport: Figs. 1, 3-4, & 11; Abstract; ¶¶91-98**), the method comprising: receiving the electromagnetic radiation at a field-enhancing structure, generating an enhanced electric field at the FES, emitting light from an electroluminescent (EL) material, and detecting the light emitted by the EL material (**Figs. 1, 3-4, & 11; Abstract; ¶¶48-51; ¶¶73-74; ¶¶91-98; ¶¶178-186; ¶¶189-196**), and wherein emitting light from the EL material comprises emitting infrared light (**¶¶91-98 In one embodiment, the irradiated electromagnetic radiation is broad-band. In one embodiment, the emitted electromagnetic radiation (emitted form devices of the invention) is in the near IR range; ¶109; ¶¶171-173; ¶178; ¶196**).

In view of the ability to enhance the electromagnetic field through the arrangement of conductive structures, electroluminescent material, and a dielectric silicon dioxide layer which enhances nonlinear phenomenon within the dielectric layer as is disclosed in **Rapaport** at **Paragraphs 5-21**, it would have been obvious before the effective filing date of the claimed invention to combine the teachings of **Rapaport** with the teachings of **Bergeron** and **Szeles et al.** to obtain enhancement in the optical signal and electric signal generated in the combination in the infrared range.

21. Claim 28 is/are rejected under 35 U.S.C. 103 as being unpatentable over **Bergeron (US Pub. 2013/0341529)** and **Szeles et al. (US Pub. 2010/0078559)** as applied to claim 20 above, and further in view of **Paeschke et al. (WO 2014/067922 published 08 May 2014 corresponding to US Pub. 2015/0294177 referred to below for convenience)**.

Regarding claim 28, **Bergeron** and **Szeles et al.** disclose the method of claim 20, but are silent regarding a lens.

In a related field of endeavor, **Paeschke et al.** discloses a method for detecting electromagnetic radiation including at least one spectral component having a frequency within an infrared range (**Paeschke et al.: Fig. 1 apparatus 1 CCD chip 3 evaluation device 4 lens 5 1st source 8 2nd source 9; Abstract; ¶¶9-14; ¶22**), comprising: receiving the electromagnetic radiation, emitting light from the EL material, and detecting the light emitted by the EL material (**Fig. 1 apparatus 1 CCD chip 3 evaluation device 4 lens 5 1st source 8 2nd source 9; Abstract; ¶¶9-14; ¶22**), wherein detecting the light comprises: transmitting the light through a lens; and detecting the light transmitted through the lens using a detector (**Fig. 1 apparatus 1 CCD chip 3 evaluation device 4 lens 5 1st source 8 2nd source 9; Abstract; ¶¶9-14; ¶22; ¶78; ¶¶86-88**).

In view of the ability to use optical elements, e.g. lenses or other elements, to generate an optical image from electroluminescent material as is disclosed in **Paeschke et al.** at **Paragraphs 22, 78, & 86-88**, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to combine the teachings of **Paeschke et al.** with the teachings of **Bergeron** and **Szeles et al.** to assist in image formation of emission from electroluminescent material and obtain a desired resolution.

Conclusion

22. Any inquiry concerning this communication or earlier communications from the examiner should be directed to JEREMY S. VALENTINER whose telephone number is (571)272-7504. The examiner can normally be reached on Monday-Friday, 8 am - 5 pm EDT.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Dave Porta can be reached on 571-272-2444. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DAVID PORTA/
Supervisory Patent Examiner, Art Unit 2884

/JEREMY S. VALENTINER/
Examiner, Art Unit 2884