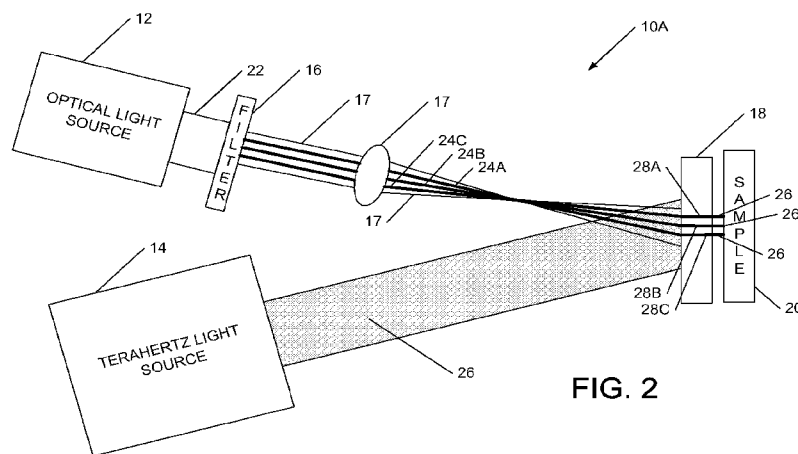




- (51) International Patent Classification:
G01N 21/35 (2006.01) *G02F 1/00* (2006.01)
- (21) International Application Number:
PCT/US2011/065734
- (22) International Filing Date:
19 December 2011 (19.12.2011)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/425,007 20 December 2010 (20.12.2010) US
- (71) Applicant (for all designated States except US): **THE UNITED STATES OF AMERICA, AS REPRESENTED BY THE SECRETARY, DEPARTMENT OF HEALTH AND HUMAN SERVICES OFFICE OF TECHNOLOGY TRANSFER, NATIONAL INSTITUTES OF HEALTH** [US/US]; 6011 Executive Boulevard, Suite 325, MSC 7660, Bethesda, MD 20892-7660 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **YORK, Andrew** [US/US]; 4890 Battery Lane, Apt. 409, Bethesda, MD 20814 (US). **SHROFF, Hari** [US/US]; 2755 Ordway Street, #511, Washington, DC 20008 (US). **AUBUCHON, Matthew** [US/US]; 2292 Creek Hollow Place, Escondido, CA 92026 (US).
- (74) Agent: **SCOTT, Teddy, C., Jr.**; Polsinelli Shughart PC, 100 South Fourth Street, Suite 1000, St. Louis, MO 63102 (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, MD, 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: TERAHERTZ SPATIAL LIGHT MODULATOR SYSTEM FOR ADAPTIVE NEAR-FIELD IMAGING



(57) Abstract: A spatial light modulator system for adaptive near-field imaging having an optical source for transmitting an optical beam through a filter which is controlled to convert the optical light beam into a filtered optical light beam to define one or more transmission pathways through a photoconductive material is disclosed. The system further includes a terahertz light source for transmitting a terahertz beam through the one or more transmission pathways defined by the filtered optical light beam through the photoconductive material for illuminating and scanning the sample without the use of moving structural components.

TERAHERTZ SPATIAL LIGHT MODULATOR SYSTEM FOR ADAPTIVE NEAR-FIELD IMAGING

RELATED APPLICATIONS

[0001] This application claims priority to U.S. Patent Application No. 61/425,007, filed December 20, 2010, and entitled TERAHERTZ SPATIAL LIGHT MODULATOR SYSTEM FOR ADAPTIVE NEAR-FIELD IMAGING, the entire contents of which are incorporated herein by reference.

FIELD

[0002] This document relates to a terahertz spatial light modulator system, and in particular to a terahertz spatial light modulator system for adaptive near-field imaging.

BACKGROUND

[0003] The lowest frequency vibration motions of many large biological molecules are in the terahertz frequency band. Terahertz radiation is also non-ionizing making it a good choice to study delicate biological systems like cells and tissue. However, the long wavelength of terahertz radiation limits the spatial resolution in diffraction-limited microscopes to a few hundred microns.

[0004] A near-field terahertz imaging system has been demonstrated to improve spatial resolution by positioning a sub-wavelength fixed aperture between the sample and either the terahertz radiation source or the terahertz radiation detector. The near-field imaging system then mechanically raster scans a sample with the terahertz radiation through the fixed aperture. In this type of arrangement, spatial resolution is determined by the aperture size rather than the terahertz wavelength. Accordingly, the combination of micron-scale spatial resolution and terahertz frequency can match particular characteristic sizes and spectra of many important biological systems to be imaged.

[0005] However, as noted above, existing terahertz near-field imaging systems must mechanically raster scan the sample, thereby requiring moving structural components to accomplish scanning of the sample. As such, there is a need in the art for a terahertz spatial light modulator system for adaptive near-field imaging that overcomes the limitations of prior art systems by

scanning a sample without the need for a fixed aperture and/or moving structural components to accomplish the same.

SUMMARY

[0006] In an embodiment, a spatial light modulator system may include a first light source for transmitting a first light beam having a first frequency and a second light source for transmitting a second light beam having a second frequency, wherein the first frequency of the first light beam is greater than the second frequency of the second light beam. A photoconductive material having opaque properties is in communication with the first light source and the second light source such that the first light beam is transmitted by the first light source through the photoconductive material to manipulate the opaque properties of the photoconductive material to define one or more transmission pathways by the first light beam through the photoconductive material that permit the second light beam to be transmitted only through one or more transmission pathways defined through the photoconductive material.

[0007] In another embodiment, a computer-controlled adaptive imaging for a spatial light modulator system may include spatial light modulator system having a first light source for transmitting an optical beam, a second light source for transmitting a terahertz light beam, a filter in communication with the first light source, and a photoconductive material having opaque properties in communication with the first light source and the second light source. The filter converts the optical beam into a filtered light beam to be transmitted through the photoconductive material to manipulate the opaque properties of the photoconductive material such that one or more transmission pathways are defined by the filtered optical beam, wherein the terahertz light beam is transmitted only through one or more transmission pathways defined through the photoconductive material. A processor may control the filter to convert the optical beam into the filtered optical beam to define the one or more transmission pathways.

[0008] In yet another embodiment, a sensor system may include a sensor head having a first light source for transmitting an optical beam and a second light source for transmitting a terahertz light beam. A filter is in communication with the first light source and a photoconductive material

having opaque properties is in communication with the first light source and the second light source. The filter converts the optical beam into a filtered optical beam to be transmitted through the photoconductive material such that one or more transmission pathways are defined by the filtered optical beam. The terahertz beam is transmitted only through the one or more transmission pathways defined through the photoconductive material to illuminate a sample with a detector in communication with the sample for detecting the terahertz beams radiated by the sample.

[0009] In one embodiment, method for adaptive near-field imaging for a spatial light modulator system may include:

providing a spatial light modulator system having:

- a first light source for transmitting an optical beam and a second light source for transmitting a terahertz beam,
- a filter in communication with the first light source, and
- a photoconductive material having opaque properties in communication with the first light source and the second light source;

transmitting the optical beam from the first light source through the filter;

controlling the filter to convert the optical beam to a filtered optical beam such that the filtered optical beam defines one or more transmission pathways through the photoconductive material by the filtered optical beam; and

transmitting the terahertz beam from the second light source to the photoconductive material such that the terahertz beam is transmitted only through the one or more transmission pathways defined through the photoconductive material

[00010] Additional objectives, advantages and novel features will be set forth in the description which follows or will become apparent to those skilled in the art upon examination of the drawings and detailed description which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

[00011] FIG. 1 is a simplified illustration showing one embodiment of the terahertz spatial light modulator system;

[00012] FIG. 1A is a simplified illustration of a photoconductive material used in the terahertz spatial light modulator system of FIG. 1 that forms a transmission pathway through the photoconductive material using a light source;

[00013] FIG. 2 is a simplified illustration showing another embodiment of the terahertz spatial light modulator system;

[00014] FIG. 2A is a simplified illustration of the photoconductive material used in the embodiment of the terahertz spatial light modulator system of FIG. 2 that forms a plurality of transmission pathways through the photoconductive material using an optical light source;

[00015] FIG. 3 is a simplified illustration showing an embodiment of the terahertz spatial light modulator system directed to a sensor head arrangement;

[00016] FIG. 4 is a simplified illustration showing an embodiment of the terahertz spatial light modulator system having a transmitter and detector arrangement; and

[00017] FIG. 5 is a flow chart illustrating a method for adaptive near-field imaging using the spatial light modulator system.

[00018] Corresponding reference characters indicate corresponding elements among the view of the drawings. The headings used in the figures should not be interpreted to limit the scope of the claims.

DETAILED DESCRIPTION

[00019] In physics, terahertz radiation refers to electromagnetic waves propagating at frequencies in the terahertz range. It has been known that the lowest vibration motions of many large biological molecules are in this terahertz frequency range, thereby making this frequency range suitable for studying delicate biological systems. However, the long wavelength of terahertz radiation limits the spatial resolution in diffraction-limited microscopes to only a few hundred microns. To address this limitation, near-field terahertz imaging systems have been developed to improve spatial resolution by positioning a sub-wavelength fixed aperture between the sample and either a terahertz radiation source or terahertz radiation detector. Although near-field terahertz imaging systems have improved spatial resolution, such imaging systems require that the sample be mechanically scanned to completely scan the entire sample, therefore requiring moving structural components to accomplish the scanning process.

[00020] As such, embodiments of the terahertz spatial light modulator system as set forth herein include particular components, properties and characteristics that address issues related to image resolution and scanning capability of a near-field terahertz imaging systems. The terahertz spatial light modulator described herein includes an optical light source that manipulates the opaque properties of a photoconductive material for defining one or more transmission pathways to permit transmission of a terahertz light beam only through the one or more transmission pathways for scanning a sample with the terahertz light beam without any issues inherent to existing terahertz near-field imaging systems that require mechanical scanning of the sample. Further details of the terahertz spatial light modulator system are discussed in greater detail below.

[00021] Referring to the drawings, various embodiments of the terahertz spatial light modulator system are illustrated and generally indicated as **10** in FIGS. **1-5**. In general, as shown in FIG. **1** the spatial light modulator system **10** may include a first light source **12** that transmits a first light beam **22** having a first frequency and a second light source **14** that transmits a second light beam **26** having a second frequency with the first frequency of the first light beam **22** being greater than the second frequency of the second

light beam **26**. A photoconductive material **18** having opaque properties is in communication with the first light source **12** and the second light source **14** such that the first light beam **22** is transmitted onto the photoconductive material **18** to manipulate the opaque properties of the photoconductive material **18** for defining a transmission pathway **28** by the first light beam **22** to permit the second light beam **26** to be transmitted only through the transmission pathway **28** defined through the photoconductive material **18** by the first light beam **22**.

[00022] In an embodiment, the photoconductive material **18** may be silicon, although in other embodiments the photoconductive material **18** may be made from regular gallium arsenide or a low temperature-grown gallium arsenide.

[00023] In one embodiment, the first light source **12** may be an optical light source that transmits an optical light beam **22** in the optical frequency range, while the second light source **14** may be a terahertz light source **14** that transmits a terahertz light beam **26** in the terahertz frequency range. If the photoconductive material **18** is silicon, the optical light beam **22** may have a wavelength of between ~**200** to ~**1100** nanometers; however, if the photoconductive material is gallium arsenide, the optical light beam **22** may have a wavelength of between ~**200** to ~**930** nanometers. In an embodiment, the terahertz light beam **26** may have a very large frequency range between **0.1** to **10** THz.

[00024] In one arrangement, the optical light beam **22** may be transmitted through the photoconductive material **18** such that the opaque properties of the photoconductive material **18** are manipulated to form a particular transparent path established by optical light beam **22** by making the volume of the photoconductive material **18** surrounding the transmission pathway **28** opaque to the transmission of the terahertz light beam **26**. As such, the optical light beam **22** defines the transmission pathway **28** that allows the terahertz light beam **26** to travel through only that portion of the photoconductive material **18**. In other words, the opaque properties of the photoconductive material **18** are manipulated by the optical light beam **22** to make portions of the photoconductive material **18** opaque to the terahertz light beam **26**, rather than transparent in order to allow transmission of a terahertz

light beam **26** only through the transparent pathway **28** defined by the optical light beam **22**. Otherwise, the transmission of the terahertz light beam **26** through the photoconductive material **18** is allowed by the normal transparent state of the photoconductive material **18** to light beams in the terahertz frequencies since the photoconductive material **18** is made from a material that is transparent to the terahertz light beam **26** unless manipulated by a light beam of a different frequency, such as an optical light beam, to make portions of the photoconductive material **18** opaque to the terahertz light beam **26**.

[00025] When the optical light beam **22** interacts with the photoconductive material **18**, free carriers are generated which absorb and phase-shift terahertz radiation, thereby preventing transmission of the terahertz light beam **26** through that portion of the photoconductive material **18**. As such, the exposure of the photoconductive material **18** to the optical light beam **22** drives the photoconductor properties of the photoconductive material **18** from being terahertz-transparent to terahertz-opaque that prevents transmission of the terahertz light beam **26** through the photoconductive material **18**. However, these free carriers have a finite lifetime during which the free carriers diffuse through the photoconductive material **18**, thereby blurring the opaque pattern that defines the transmission pathway **28** induced by a patterned optical light beam **22**. As such, terminating the transmission of the optical light beam **22** allows the photoconductive material **18** to revert back to a terahertz-transparent state as the lifetimes of the free carriers expire.

[00026] When the photoconductive material **18** is silicon, such a photoconductor material has a long free carrier lifetime, so a low optical power source **12** may be used and still drive strong terahertz radiation opacity because the free carrier diffuse a long way in their longer lifetime which begins to blur the transmission pathway **28** created by the optical light beam **22**. In addition, since silicon is not **100%** opaque to the optical light beam **22**, any sample being scanned must be protected from the transmitted optical light beam **22**. Finally, since silicon is inert, the photoconductive material **18** may be placed in direct contact with the sample if desired.

[00027] When the photoconductive material **18** is a low temperature gallium arsenide, such a photoconductor material has a very

short free carrier lifetime, therefore a high optical power source **12** is required to drive the photoconductive material **18** into an opaque state to a terahertz light beam **26**. However, the free carriers do not diffuse very far in the carrier's short lifetime so the transmission pathways **28** defined by the optical light beam **22** are not blurred by diffusion. As such, low temperature gallium arsenide is very opaque to the optical light beam **22** so a very thin layer may be used as the photoconductive material **18** without having issues related to the optical light beam **22** leaking through the material **18**. In contrast to silicon, gallium arsenide is not chemically inert, and therefore an inert coating may be applied to the photoconductive material **18** in order to protect the sample being scanned. When the photoconductive material **18** is regular gallium arsenide, such a photoconductor material has properties that lie between silicon and low temperature gallium arsenide, such as having medium free carrier lifetime and medium blurring of the transmission pathway **28**. Regular gallium arsenide is very opaque and not chemically inert.

[00028] As shown in FIGS **1** and **1A**, when the optical light beam **22** is transmitted through the photoconductive material **18**, the opaque properties of the photoconductive material **18** are manipulated in a manner that creates the transmission pathway **28** through the photoconductive material **18** for allowing the transmission of the terahertz light beam **26**, while the photoconductive material **18** is opaque to the transmission of the terahertz light beam **26** through other portions of the photoconductive material **18** that would otherwise be transparent to the transmission of the terahertz light beam **26**. In one embodiment, the size (e.g., diameter or width) and configuration (e.g., round, oval, etc) of the transmission pathway **28** may be dictated by the configuration of the optical light beam **22** transmitted through the other portions of the photoconductive material **28**. As such, the size and configuration terahertz light beam **26** may also dictated by the size and configuration of the optical light beam **22** that manipulates the opaque properties of the photoconductive material **18** for establishing a transparent path through the transmission pathway **28**. As used herein, the term "transmission pathway" refers to an optical pathway that is transparent to the transmission through the photoconductive material **18** by a light beam in the terahertz frequency.

[00029] Referring to FIG. 2, another embodiment of the terahertz spatial light modulator system, designated **10A**, is illustrated. The spatial light modulator system **10A** may include an optical light source **12** that transmits an optical light beam **22** through a light filter **16** for converting the optical light beam **22** into a filtered optical light beam **24** that may be transmitted by the light filter **16** at different or concurrent times and along one or more pathways through the photoconductive material **18**. This arrangement allows one or more transmission pathways **28** to be defined through the photoconductive material **18** at a particular time and location as controlled by the light filter **16**. In one embodiment, the light filter **16** may be a Light Crystal Display (LCD) for filtering the optical light beam **22** into a filtered light beam **24** using the light modulating properties of liquid crystals that fill any number of pixels arrayed within the LCD of the light filter **16**. In addition, a terahertz light source **14** may be in communication with the photoconductive material **18** for transmitting a terahertz light beam **26** in the terahertz frequency range through the photoconductive material **18**. In another embodiment, the light filter **16** may also be a Digital Micromirror Device (DMD), which functions in a similar manner as an LCD, but is reflective rather than transmissive.

[00030] As shown in FIGS. 2 and **2A**, a sample **20** may be positioned on the opposite side of the photoconductive material **18** to be selectively illuminated by the terahertz light beam **26** through one or more transmission pathways **28**, for example transmission pathways **28A**, **28B**, and **28C**, defined through the photoconductive material **18** by the filtered optical light beam **24**. The filtered optical light beam **24** manipulates the opaque properties of the photoconductive material **18** from being normally transparent to the transmission of the terahertz light beam **26** based on the pattern of the filtered optical light beam **24** through the photoconductive material **18**. In one embodiment, terahertz spatial light modulator system **10A** may further include an imaging lens **17** positioned between the light filter **16** and the photoconductive material **18** for imaging the filtered optical light beam **24** through selected portions of the photoconductive material **18**. The LCD **16** may be used to create a spatially-variable pattern of opacity and transparency through the photoconductive material **18** by the filtered optical light beam **24** to selectively illuminate the sample **20** with the terahertz light beam **26**. The

transmission pathways **28** may be generated at different sequences and locations through the photoconductive material **18** as controlled by the LCD **16**. As such, the combination of the LCD **16** and optical light source **12** act to generate dynamic apertures by converting the optical light beam **22** into a filtered optical light beam **28** and focusing the filtered optical light beam **24** through the photoconductive material **18** to produce transmission pathways **28** at different times and/or in various locations along the photoconductive material **18**. Although the present embodiment shows that three transmission pathways **28A**, **28B**, and **28C** may be defined, any number of transmission pathways **28** may be generated by the LCD **16**. This procedure for manipulating the opaque properties of the photoconductive material **18** allows the sample **20** to be completely scanned by the terahertz light beam **26** without the use of structural components to perform a raster scan or similar mechanical scanning operation since any sequence of transmission pathways **28** may be generated in order to illuminate the sample **20** with the terahertz light beam **26**.

[00031] In one embodiment, the terahertz spatial light modulator system **10** may include a sensor head **11** having a housing **15** defining a window **33** with a photoconductive material **18** disposed within the window **33**. The sensor head **11** may be in operative communication with an optical light source **12** for providing an optical light beam **22** through a fiber **32**. One end of the fiber **32** is disposed within a chamber **29** defined by the housing **15** for transmitting an optical light beam **22** through a light filter, such as an LCD **16**. The LCD **16** converts the optical light beam **22** into filtered optical light beam **24** to be transmitted through the photoconductive material **18** to define one or more respective transmission pathways **28**. In an embodiment, a first imaging lens **21** may be in communication with the end of the fiber **32** for focusing the optical light beam **22** onto the LCD **16**, while a second imaging lens **23** is positioned between the LCD **16** and photoconductive material **18** for focusing the filtered optical light beam **24** from the LCD **16** onto the photoconductive material **18**.

[00032] In addition, the sensor head **11** may be in operative communication with a terahertz light source **14** that transmits a terahertz light beam **26** through an fiber **34** having one end disposed inside the chamber **29**

of the housing **15** and oriented to transmit the terahertz light beam **26** through the photoconductive material **18**. In an embodiment, the terahertz light source **14** may transmit a terahertz light beam **26** through third imaging lens **25** that focuses the terahertz light beam **26** to contact a beam splitter **31** for transmission of the terahertz light beam **26** through the fiber **34**. A fourth imaging lens **27** may be in communication with the opposite end of the fiber **34** for focusing the terahertz light beam **26** onto the photoconductive material **18** such that portion(s) of the terahertz light beam **26** may be transmitted through one or more transmission pathways **28** defined through the photoconductive material **18**. For example, the LCD **16** may generate a filtered optical light beam **24** that manipulates the opacity of the photoconductive materials **18** to form three respective transmission pathways **28A**, **28B** and **28C** that are transparent to the transmission of the terahertz light beam **26** to travel through the photoconductive material **18**; however, the LCD **16** may generate a filtered optical light beam **24** for forming any respective number of transmission pathways **28** in any sequence for completely scanning a sample **20**.

[00033] In one embodiment, the sensor head **11** may be positioned to illuminate the sample **20** with the terahertz light beam **26** that is transmitted through the transmission pathways **28** formed through the photoconductive material **18** by the filtered optical light beam **24**. Once the sample **20** is illuminated by a terahertz light beam **26**, the illuminated sample **20** generates a terahertz light beam **26** that may travel back through the same respective transmission pathway **28** of the photoconductive material **18** for transmission back through the fiber **34** for detection by a terahertz detector **13** that is directed by the beam splitter **31**. In one embodiment, the terahertz detector **13** may be photoconductive antennae or electro-optic sampling, which would provide spectrally-resolved information. In the alternative, bolometers or pyroelectric detectors could be used that provide calorimetric measurements.

[00034] As shown in FIG. 4, an embodiment of the terahertz spatial light modulator system, designated **10B**, may include a terahertz transmitter **17** in operative communication with an optical light source **12** that transmits an optical light beam **22** that is converted into a filtered optical light

beam **24** for forming one or more transmission pathways **28** (e.g., FIG. 2) through the photoconductive material **18** by causing other portions of the photoconductive material **18** to become opaque to the terahertz light beam **26**. A terahertz light source **14** is in operative communication with the transmitter **17** for transmitting a terahertz light beam **26** through the one or more transmission pathways **28** defined through the photoconductive material **18** by the filtered optical light beam **24**. The terahertz light beam **26** illuminates a sample **20**. The illuminated sample **20** then radiates terahertz light beams **26** that are then detected by a terahertz detector **13**. In this arrangement, the sample **20** should be relatively close to the photoconductive material **18** (e.g., less than a terahertz wavelength) since a large enough gap between the photoconductive material **18** and the sample **20** can adversely affect image resolution (e.g., less than ~**300** microns for 1 terahertz). In contrast, when the distance between the photoconductive material **18** and the sample **20** is less than one terahertz wavelength, the image resolution is determined by the size of the transmission pathway **28** which can be ~1 micron or ~**300** times better resolution.

[00035] Referring to FIG. 5, a flow chart illustrates a method for adaptive near-field imaging using the spatial light modulator system **10**. At block **1000**, the method includes providing a spatial light modulator system **10** having a first light source **12** for transmitting an optical beam **22**, a second light source **14** for transmitting a terahertz beam **26**, a filter **16** in communication with the first light source **12**, and a photoconductive material **18** in communication with the first light source **12** and the second light source **14**. At block **1002**, transmitting the optical beam **22** from the first light source **12** through the filter **16**. At block **1004**, controlling the filter **16** to define a filtered optical light beam **24** for generating one or more transmission pathways **28** through the photoconductive material **18**. At block **1006**, transmitting the terahertz beam **26** from the second light source **14** to the photoconductive material **18** such that the terahertz beam **26** is transmitted through the one or more transmission pathways **28** defined through the photoconductive material **18** to illuminate a sample **20**.

[00036] It should be understood from the foregoing that, while particular embodiments have been illustrated and described, various

modifications can be made thereto without departing from the spirit and scope of the invention as will be apparent to those skilled in the art. Such changes and modifications are within the scope and teachings of this invention as defined in the claims appended hereto.

CLAIMS

What is claimed is:

1. A spatial light modulator system comprising:
 - a first light source for transmitting a first light beam having a first frequency;
 - a second light source for transmitting a second light beam having a second frequency, wherein the first frequency of the first light beam is greater than the second frequency of the second light beam, and
 - a photoconductive material having opaque properties in communication with the first light source and the second light source such that the first light beam is transmitted by the first light source through the photoconductive material to manipulate the opaque properties of the photoconductive material to define one or more transmission pathways by the first light beam through the photoconductive material that permit the second light beam to be transmitted only through the one or more transmission pathways defined through the photoconductive material.
2. The spatial light modulator system of claim 1, further comprising:
 - a filter positioned between the first light source and the photoconductive material for converting the first light beam into a filtered first light beam to be transmitted onto the photoconductive material for manipulating the opaque properties of the photoconductive material to define the one or more transmission pathways.
3. The spatial light modulator system of claim 2, further comprising:
 - a processor for controlling the filter to convert the first light beam into the filtered first light beam to define one or more transmission pathways through the photoconductive material such that the opaque properties of the photoconductive material are manipulated by the filtered first light beam.

4. The spatial light modulator system of claim 2, wherein the filter is a light crystal display.
5. The spatial light modulator system of claim 2, further comprising:
an imaging lens for imaging the first light beam onto the
photoconductive material.
6. The spatial light modulator system of claim 1, wherein the photoconductive material is silicon, gallium arsenide, or a low temperature gallium arsenide.
7. The spatial light modulator system of claim 1, further comprising:
a sample in communication with the photoconductive material that is
illuminated by the second light beam transmitted through the one
or more transmission pathways defined through the
photoconductive material by the second light beam.
8. The spatial light modulator system of claim 1, further comprising:
a detector in communication with the photoconductive material for
detecting the second light beam illuminated by the sample.
9. The spatial light modulator system of claim 1, wherein the first light beam is an optical light beam.
10. The spatial light modulator system of claim 1, wherein the second light beam is a terahertz light beam.
11. The spatial light modulator system of claim 3, wherein a location of each respective one or more transmission pathways defined through the photoconductive material is determined by the processor converting the first light beam.
12. The spatial light modulator system of claim 1, wherein the photoconductive material is normally transparent to the second light beam.
13. The spatial light modulator system of claim 12, wherein the first light beam causes the photoconductive material to become opaque to the transmission of the second light beam through the photoconductive material.

14. The spatial light modulator system of claim 1, wherein the first light beam has a wavelength range between 200-1100 nanometers.
15. The spatial light modulator system of claim 1, wherein the second light beam has a range in frequency between 0.1-10 terahertz.
16. A computer-controlled adaptive imaging for a spatial light modulator system comprising:
 - a first light source for transmitting an optical beam;
 - a second light source for transmitting a terahertz beam,
 - a filter in communication with the first light source,
 - a photoconductive material having opaque properties in communication with the first light source and the second light source, wherein the filter converts the optical beam into a filtered optical beam to be transmitted through the photoconductive material to manipulate the opaque properties of the photoconductive material such that one or more transmission pathways are defined by the filtered optical beam, wherein the terahertz beam is transmitted through the one or more transmission pathways defined through the photoconductive material, and
 - a processor for controlling the filter to convert the optical beam into the filtered optical beam to define the one or more second transmission pathways.
17. The computer-controlled adaptive imaging for a spatial light modulator system of claim 16, wherein the photoconductive material is silicon, gallium arsenide, or a low temperature gallium arsenide.
18. The computer-controlled adaptive imaging for a spatial light modulator system of claim 16, further comprising:
 - a detector for detecting the terahertz beam transmitted through the photoconductive material.
19. The computer-controlled adaptive imaging for a spatial light modulator system of claim 16, wherein a location of the one or more transmission pathways defined through the photoconductive material is controlled by the processor.

20. The computer-controlled adaptive imaging for a spatial light modulator system of claim 16, wherein the filter is a light crystal display.
21. A sensor system comprising:
a sensor head comprising
a first light source for transmitting an optical beam and a second light source for transmitting a terahertz beam,
a filter in communication with the first light source,
a photoconductive material having opaque properties in communication with the first light source and the second light source, wherein the filter is controlled to convert the optical beam into a filtered optical beam to be transmitted through the photoconductive material such that one or more transmission pathways are defined by the filtered light beam, wherein the terahertz beam is transmitted through one or more transmission pathways defined through the photoconductive material; and
a detector in communication with a sample for detecting the terahertz beams radiated by the sample.
22. The sensor apparatus of claim 21, further comprising:
a beam splitter in communication with the second light source for transmitting the terahertz beam through the photoconductive material and transmitting the portion of the terahertz beam onto the detector.
23. The sensor apparatus of claim 22, further comprising:
a first lens in communication with the second light source and the beam splitter for focusing the terahertz beam onto the beam splitter.
24. The sensor apparatus of claim 22, further comprising:
a cable for transmitting the terahertz beam from the beam splitter; and
a second lens in communication with the cable for focusing the terahertz beam onto the photoconductive material in one

direction and for focusing the terahertz beam back through the cable in an opposite direction.

25. The sensor apparatus of claim 21, further comprising:
a processor in communication with the filter for controlling the filter to convert the optical beam into the filtered optical beam to define the one or more transmission pathways.
26. A method for adaptive near-field imaging for a spatial light modulator system comprising:
providing a spatial light modulator system comprising:
a first light source for transmitting an optical beam and a second light source for transmitting a terahertz beam,
a filter in communication with the first light source, and
a photoconductive material in communication with the first light source and the second light source;
transmitting the optical beam from the first light source through the filter;
controlling the filter to convert the optical beam to a filtered optical beam such that the filtered optical beam defines one or more transmission pathways through the photoconductive material by the filtered optical beam; and
transmitting the terahertz beam from the second light source to the photoconductive material such that the terahertz beam is transmitted through the one or more transmission pathways defined through the photoconductive material.
27. The method for adaptive near-field imaging of claim 26, further comprising:
providing a sample for illumination by the portion of the terahertz beam transmitted through the one or more transmission pathways defined through the photoconductive material.
28. The method for adaptive near-field imaging of claim 27, further comprising:
providing a detector for detecting the portion of the terahertz beam that illuminates the sample.

29. The method for adaptive near-field imaging of claim 27, further comprising:
controlling the liquid crystal display such that the sample is illuminated
by the terahertz beam transmitted through the one or more
transmission pathways defined through the photoconductive
material along a predetermined scanning path, wherein the
predetermined scanning path may be a single transmission
pathway or multiple transmission pathways.

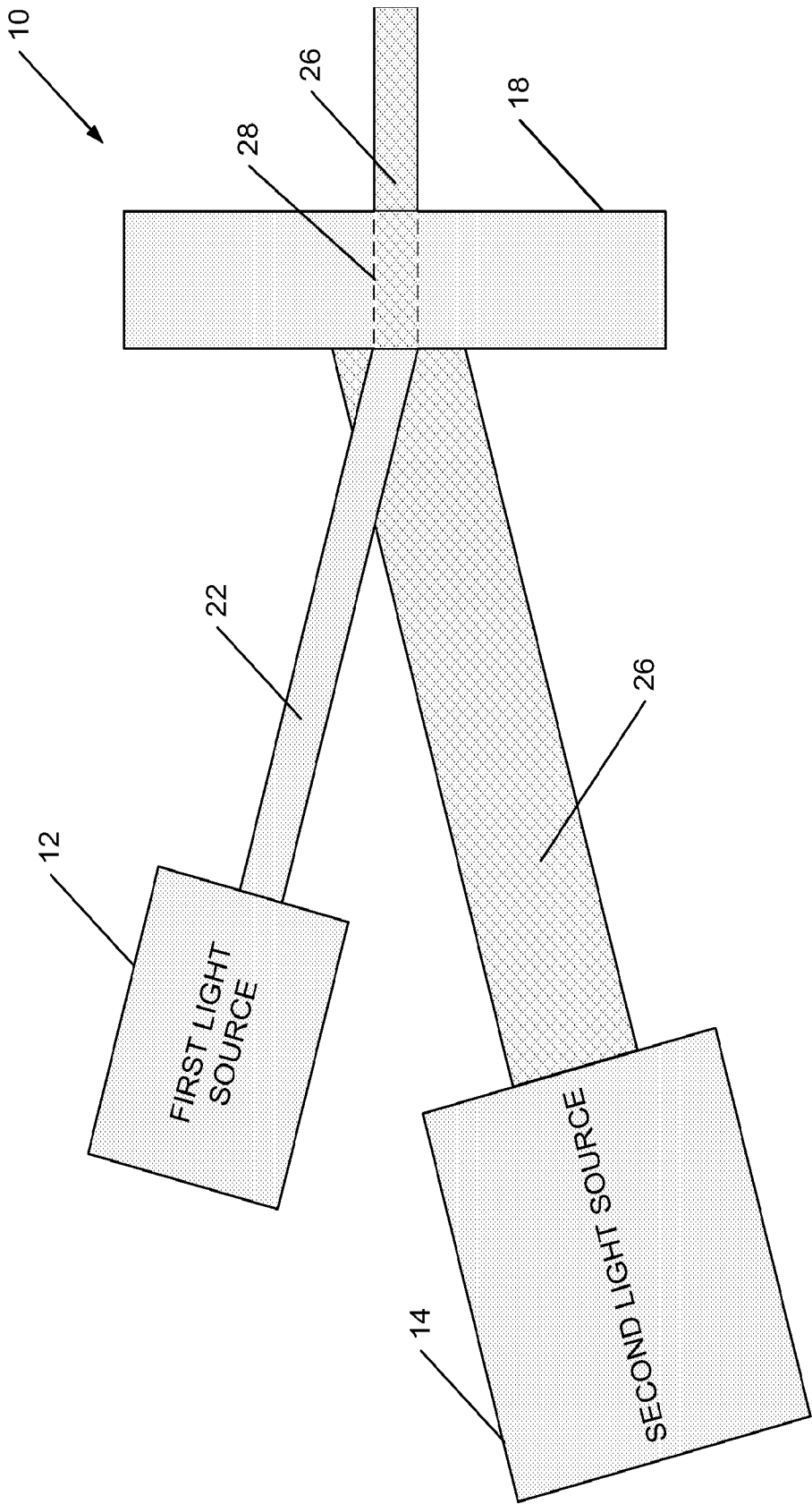
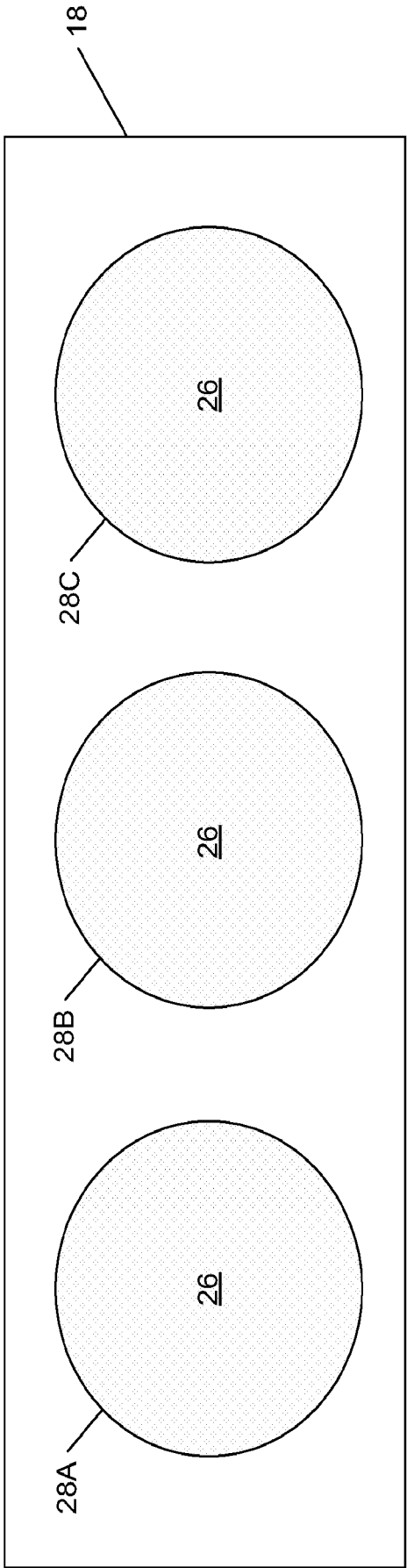
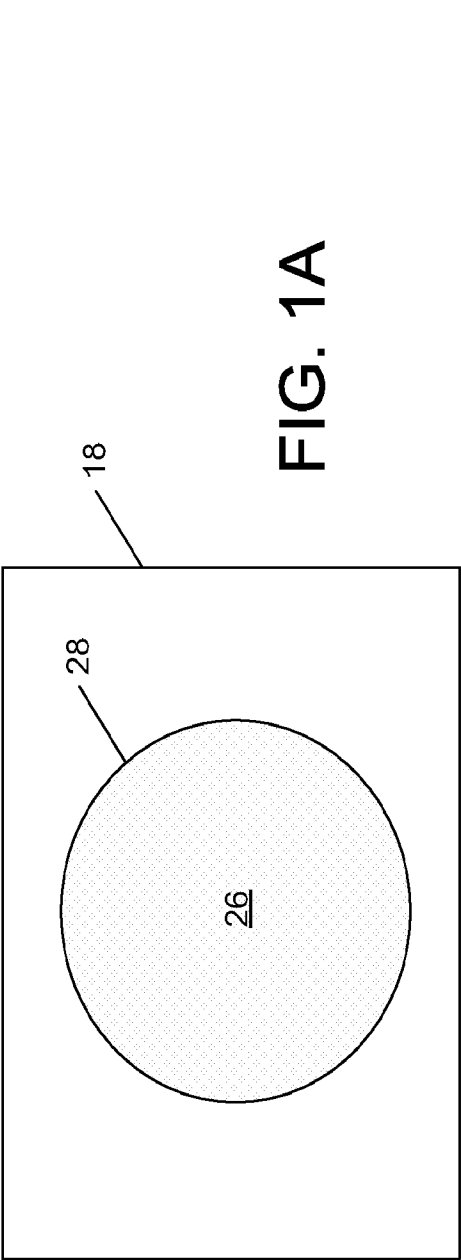


FIG. 1



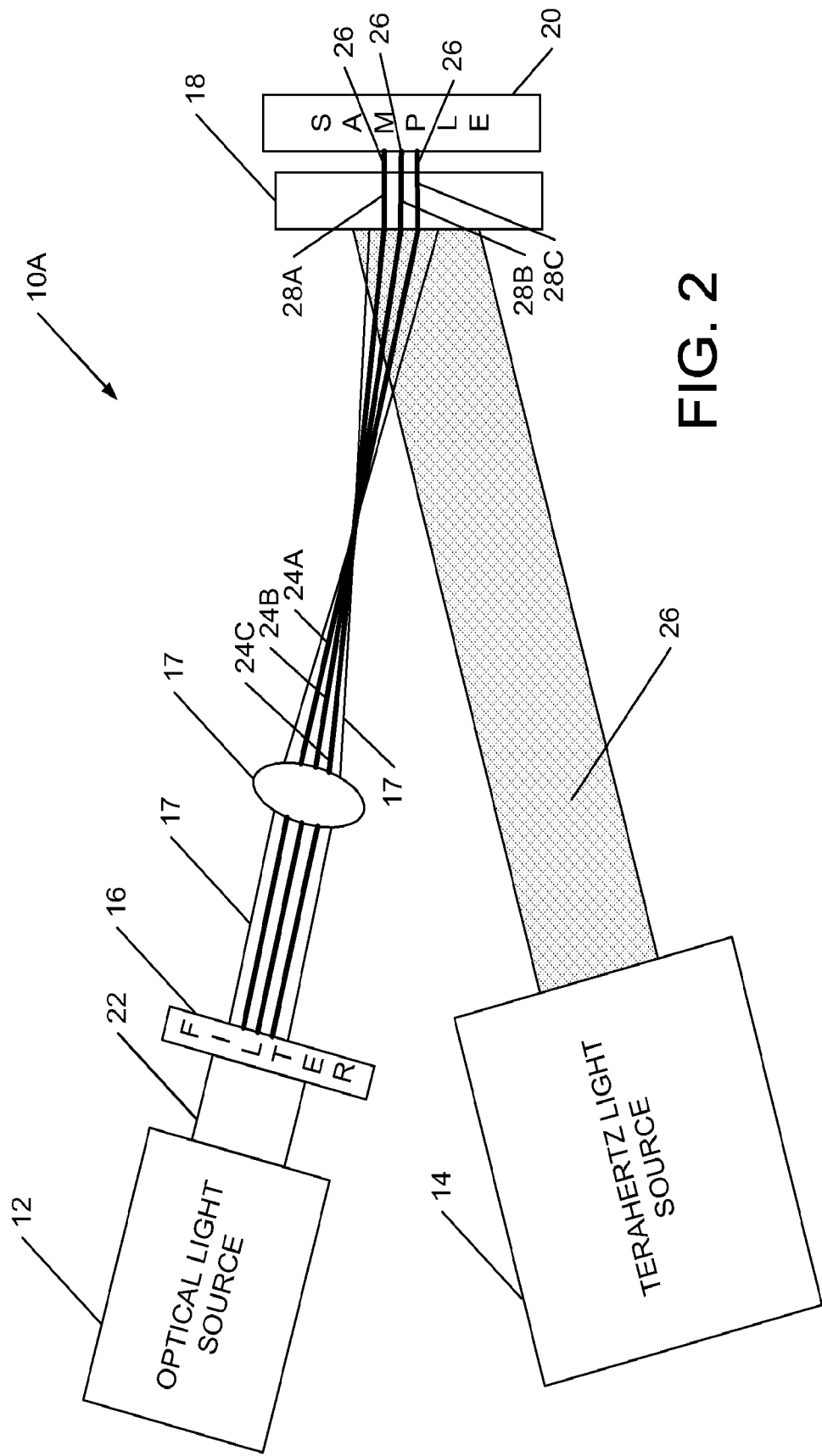
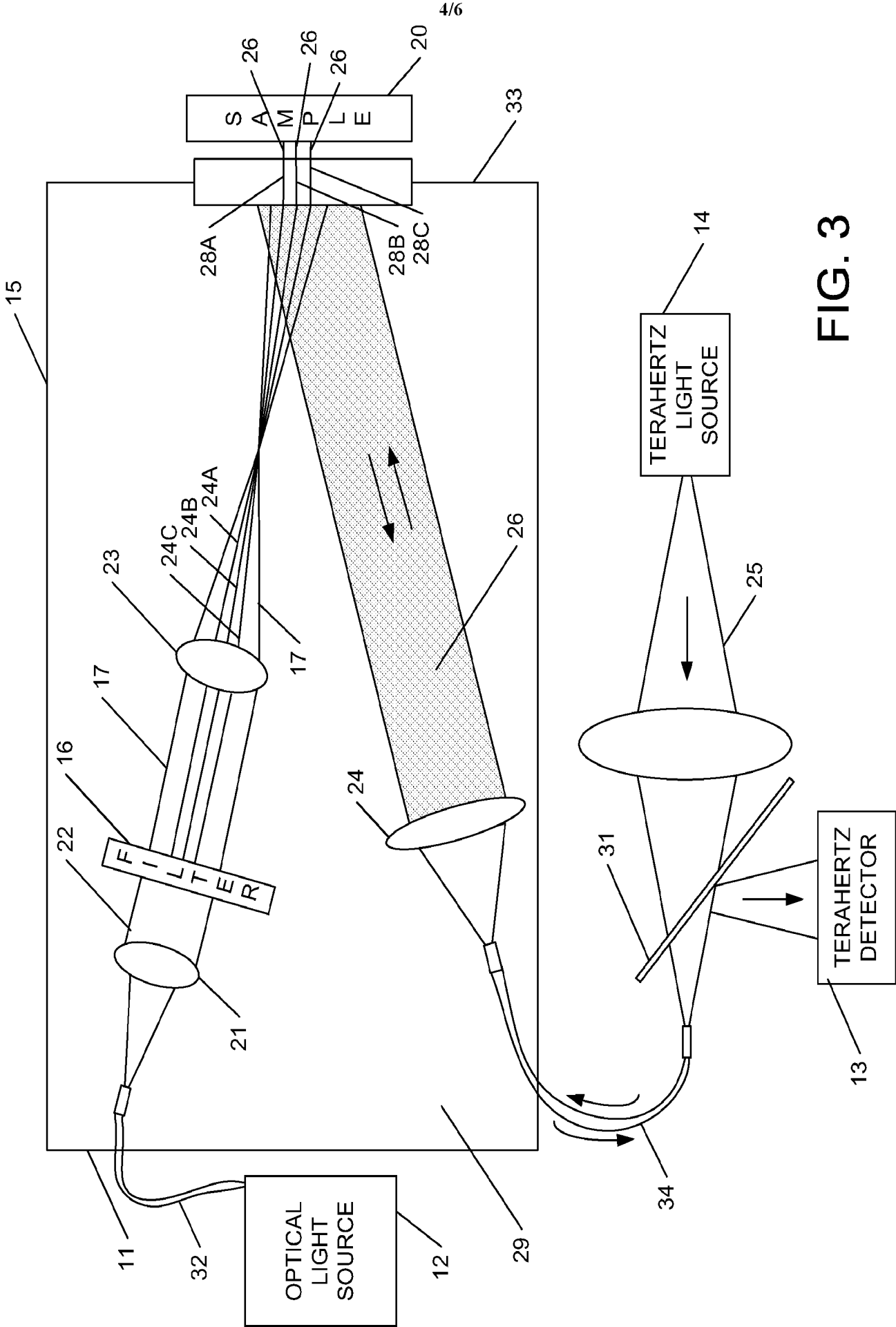


FIG. 2



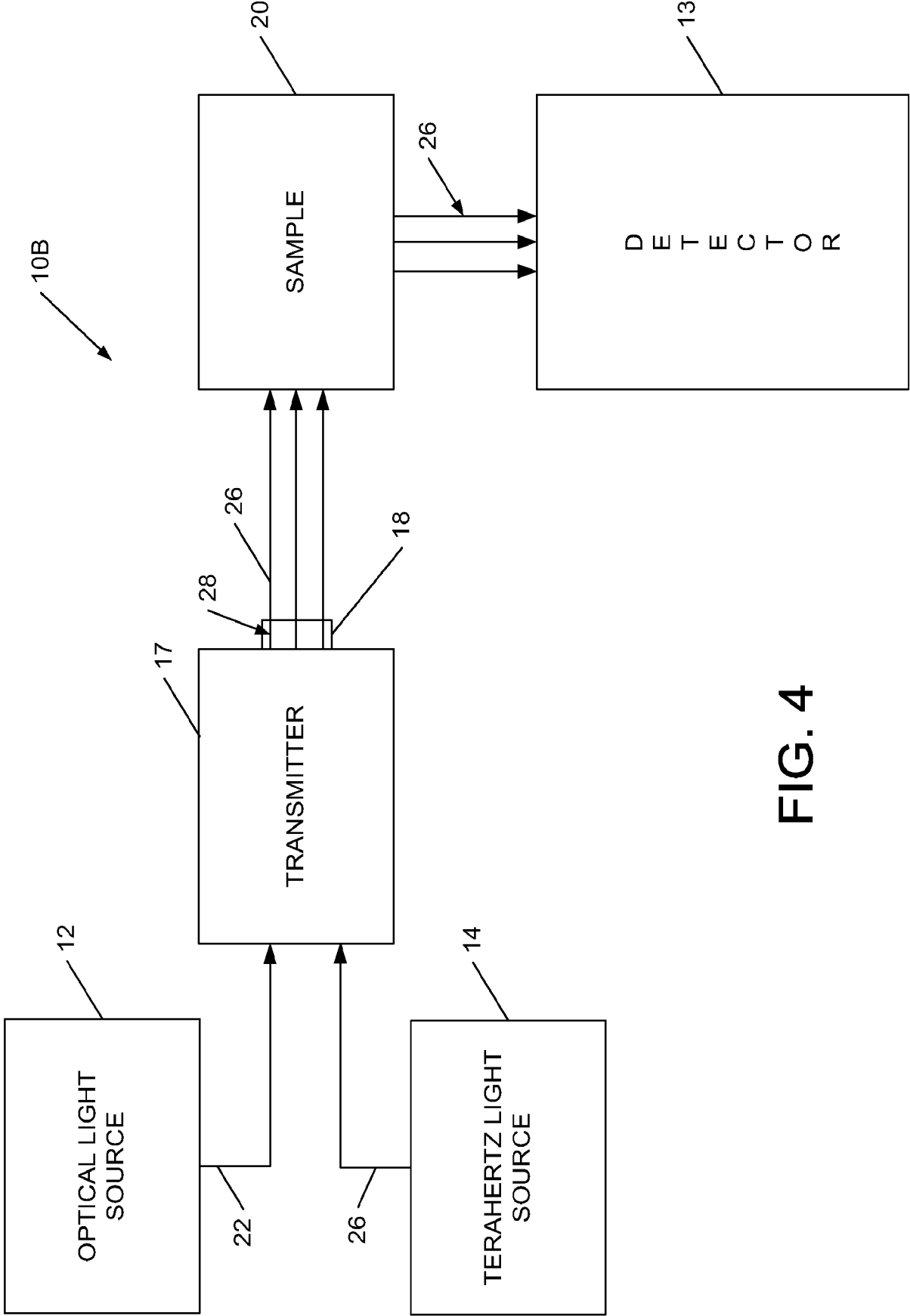


FIG. 4

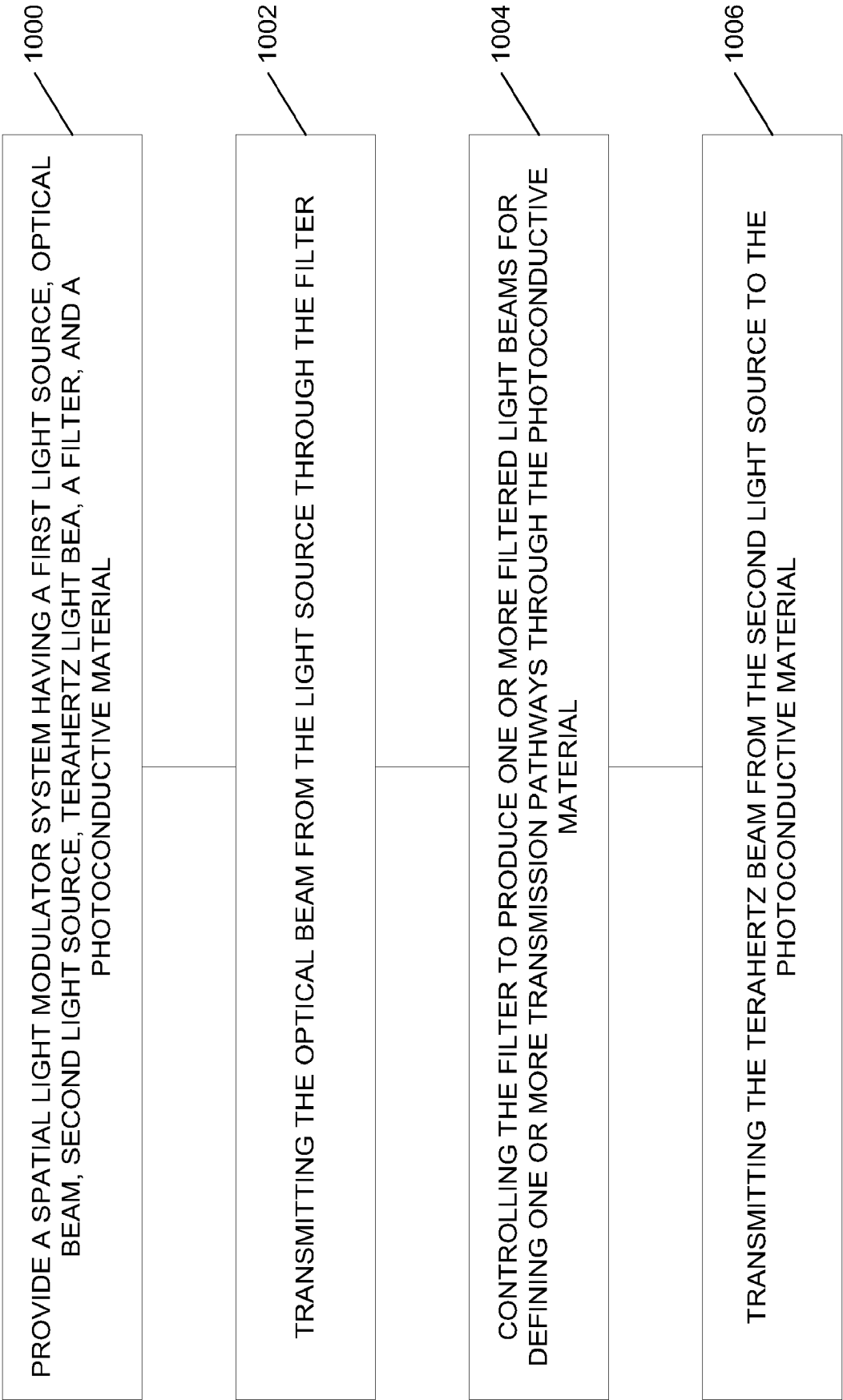


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/065734

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01N21/35 G02F1/00
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)

G01N G02F

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 practical, search terms used)

EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/153874 A1 (JIANG ZHIPING [CA] ET AL) 24 October 2002 (2002-10-24) paragraph [0050] - paragraph [0053] paragraph [0061] paragraph [0079] figures 1,2	1-29
A	----- US 6 069 727 A (CHO SUNG-MIN [KR] ET AL) 30 May 2000 (2000-05-30) abstract	1-29
A,P	----- WO 2011/103600 A2 (UNIV RICE WILLIAM M [US]; KELLY KEVIN F [US]) 25 August 2011 (2011-08-25) figures 1a,1b claims 1-10 page 8, line 8 - line 22 -----	1-29



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 document 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

19 March 2012

Date of mailing of the international search report

04/04/2012

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Rasmusson, Marcus

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2011/065734

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2002153874 A1	24-10-2002	NONE	

US 6069727 A	30-05-2000	JP 3220061 B2	22-10-2001
		JP 10114106 A	06-05-1998
		US 6069727 A	30-05-2000

WO 2011103600 A2	25-08-2011	NONE	
