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(54) **NANO-TEXTURED ATTENUATOR FOR USE WITH LASER BEAM PROFILING AND LASER BEAM CHARACTERIZATION SYSTEMS AND METHOD OF USE**

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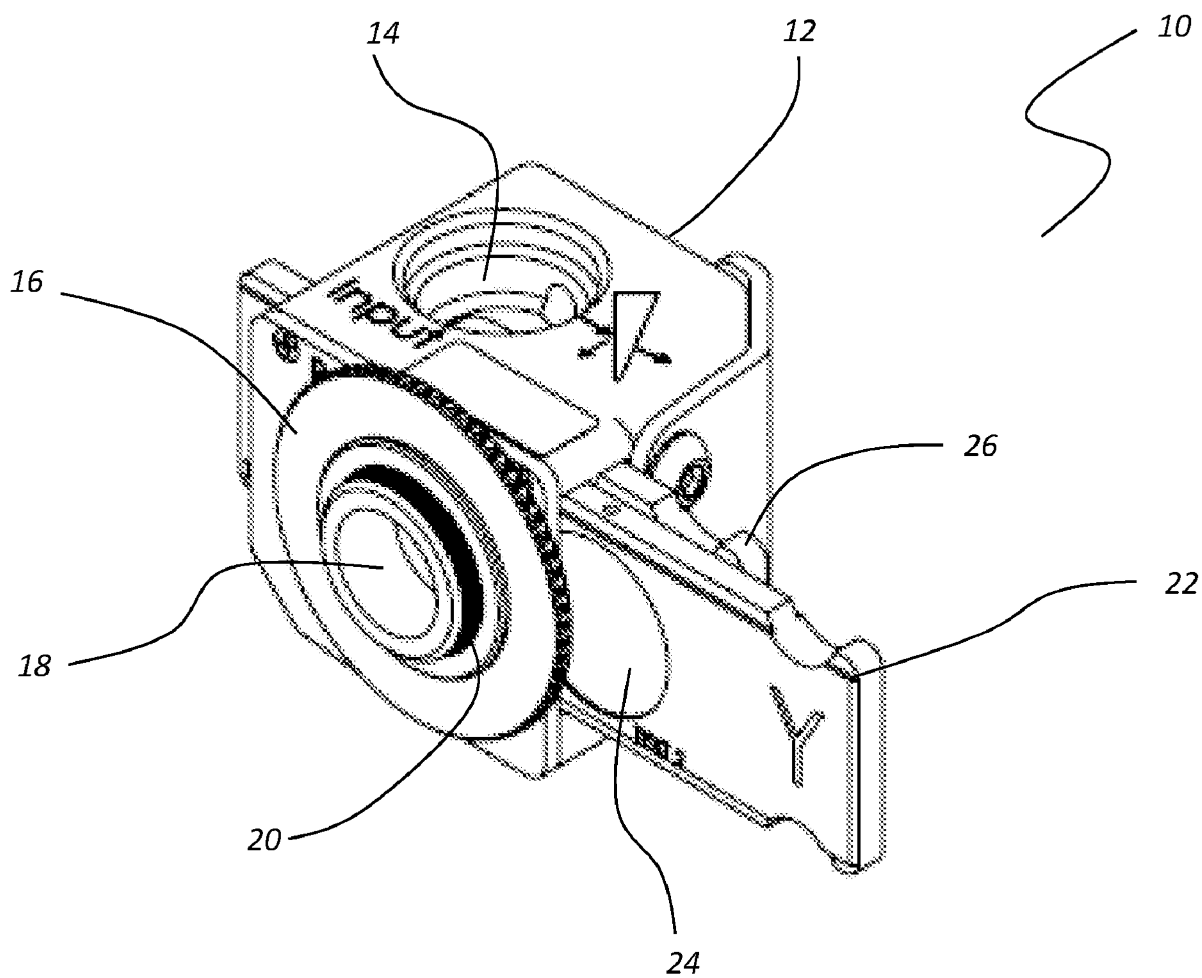
CPC ***G02B 27/281*** (2013.01); ***G01J 1/4257*** (2013.01)

(57) **ABSTRACT**

The present application discloses a nano-textured attenuator which includes a body defining in in the aperture, a measurement aperture, at least one beam dump aperture, at least one coupling fixture may be formed on or positioned on the body, a first nano-textured beamsplitter is positioned within the body and configured to transmit 85% to 99.9999% of an input signal therethrough while reflecting 0.0001% to form at least one partially attenuated signal, at least a second nano-textured beamsplitter is positioned within the body and is configured to transmit 85% to 99.9999% of an input signal therethrough while reflecting 0.0001% to form at least one attenuated measurement signal, and at least one camera is communication with the measurement aperture be configured to measure at least one optical characteristic of the attenuated measurement signal.



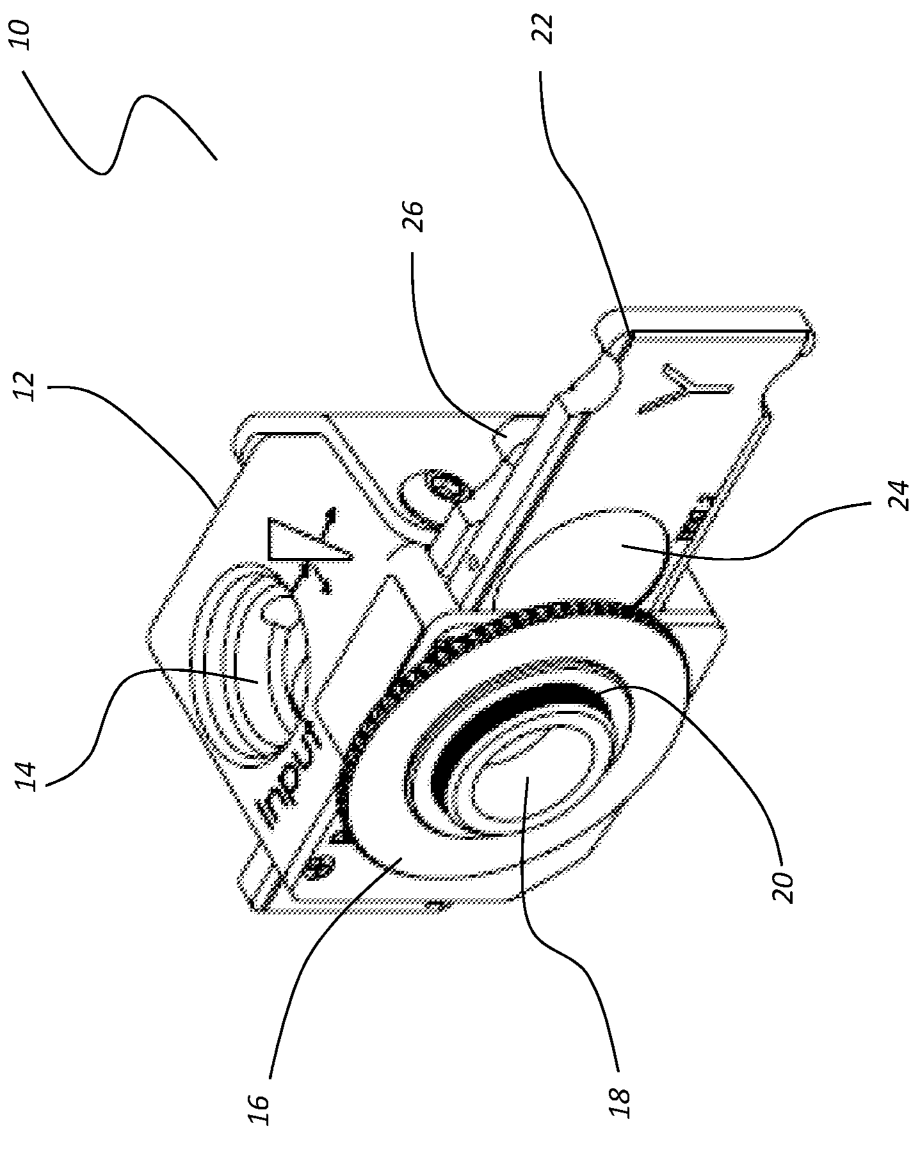


Fig. 1

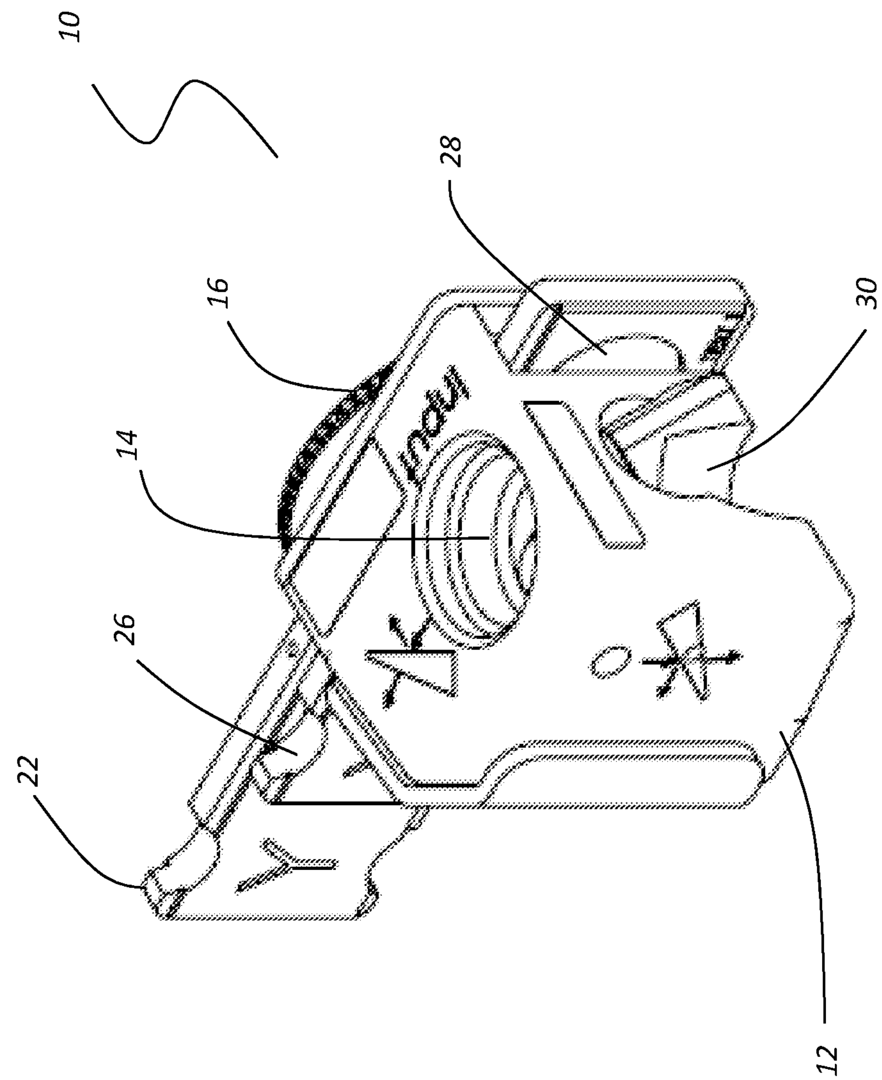


Fig. 2

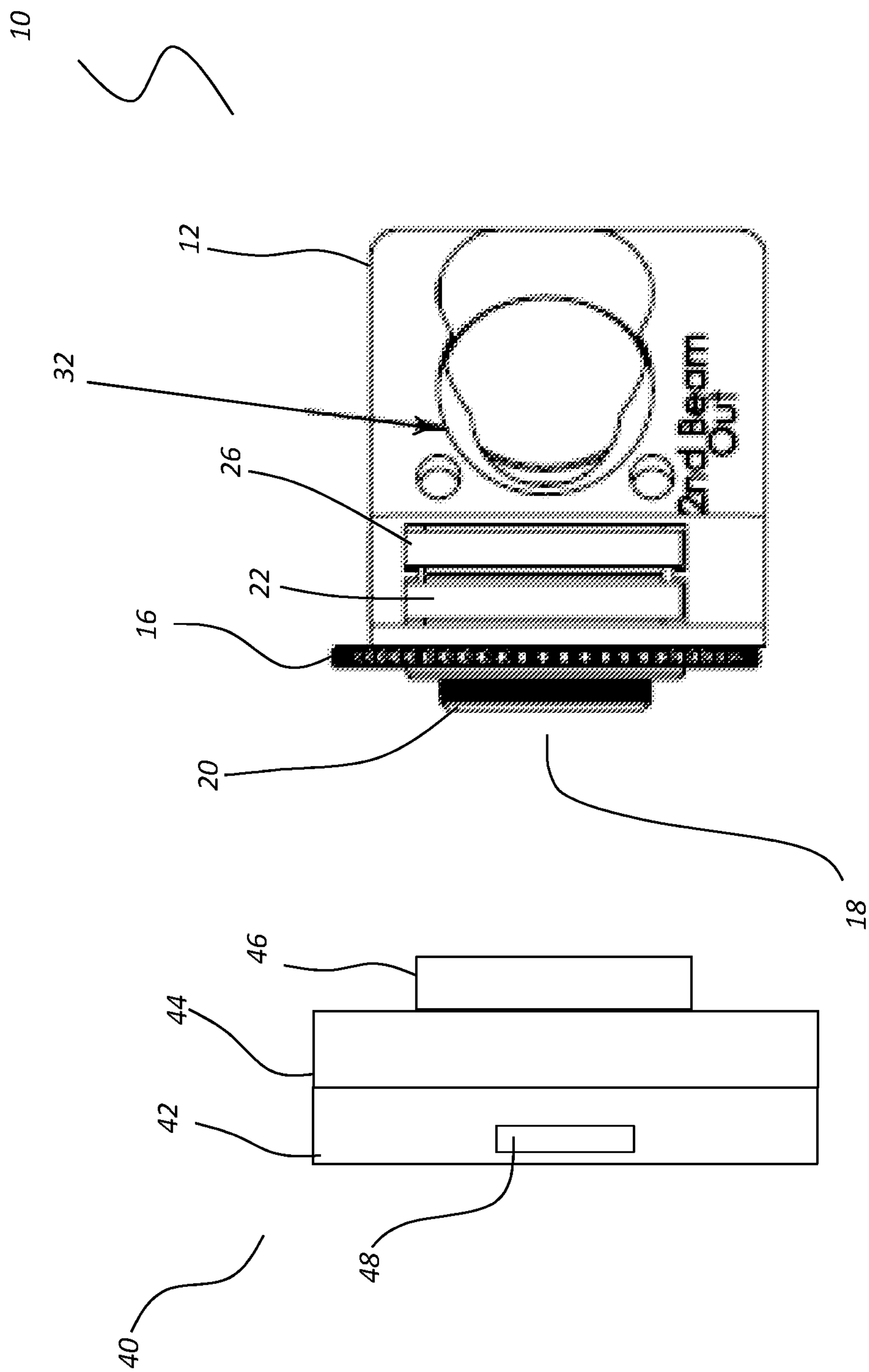


Fig. 3

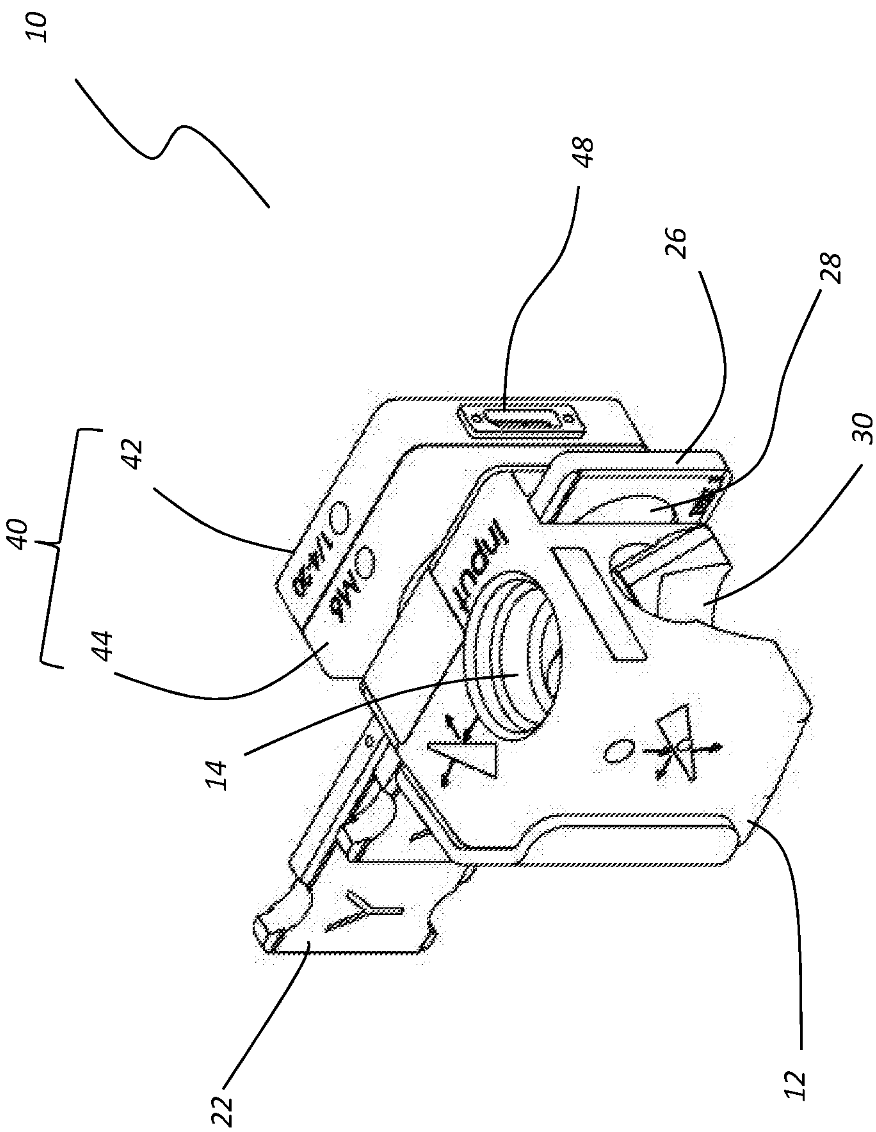


Fig. 4

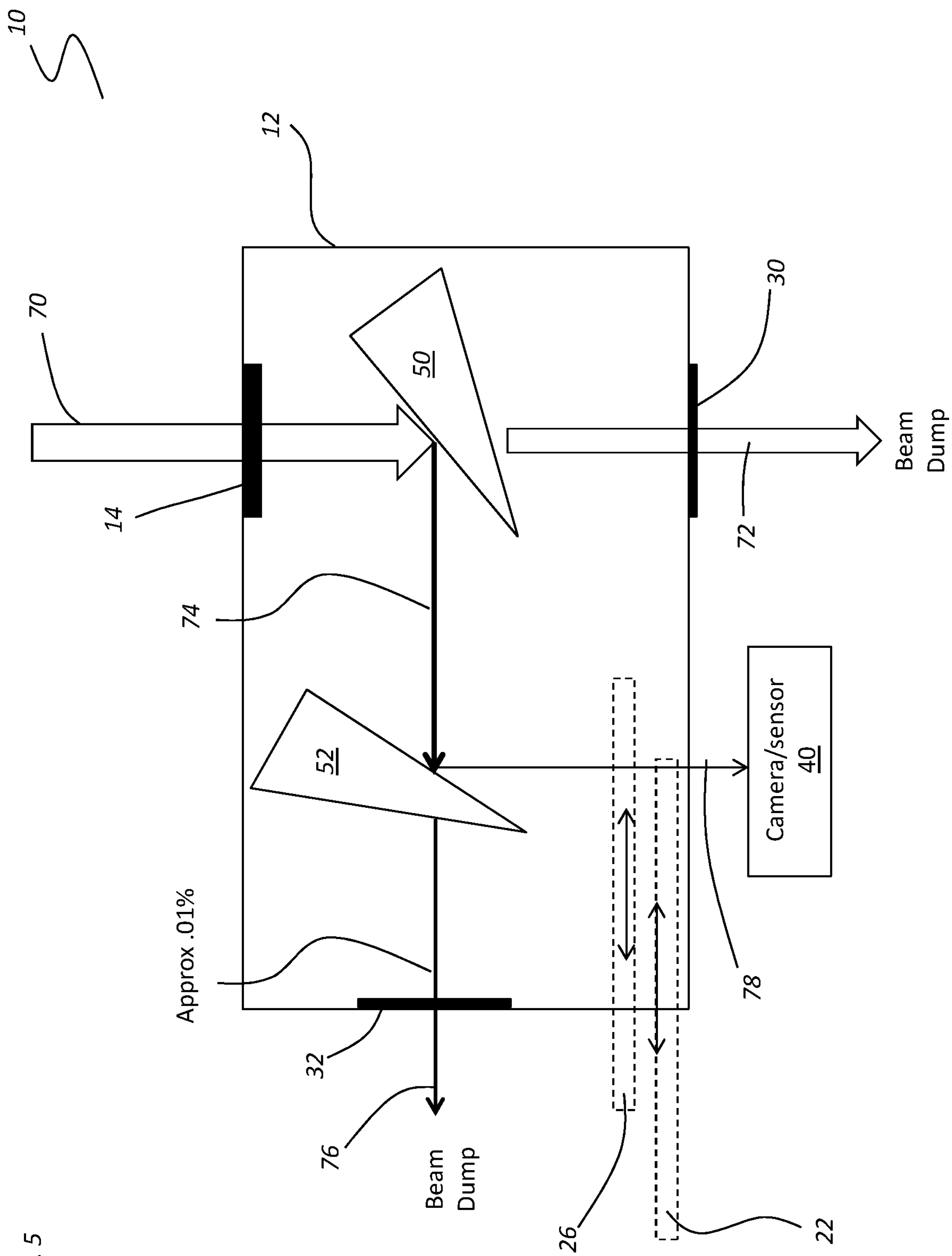

10
12
70
50
30
14
Beam
Dump
72
74
52
Camera/sensor
40
Approx .01%
78
32
76
Beam
Dump
26
22

Fig. 5

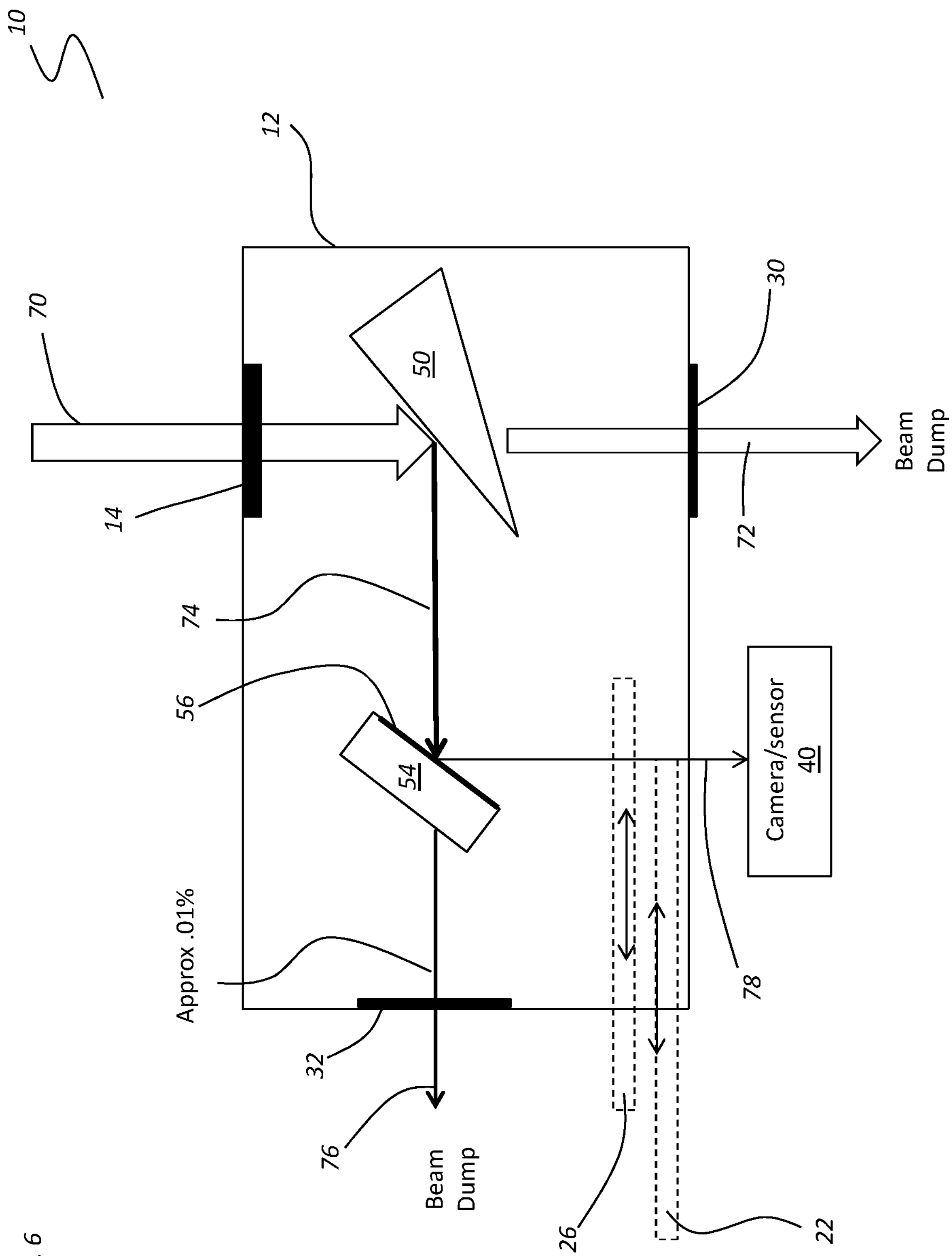

10
12
70
50
30
14
Beam Dump
72
74
56
Camera/sensor 40
54
Approx .01%
78
32
76
Beam Dump
26
22

Fig. 6

NANO-TEXTURED ATTENUATOR FOR USE WITH LASER BEAM PROFILING AND LASER BEAM CHARACTERIZATION SYSTEMS AND METHOD OF USE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to U.S. Provisional Patent Application Ser. No. 62/865,160, filed on Jun. 22, 2019 and entitled "Nano-Textured Attenuator for Use with Laser Beam Profiling and Laser Beam Characterization Systems and Methods of Use," the entire contents of which are incorporated by reference herein.

BACKGROUND

[0002] Increasingly, laser systems offering high output powers from about 500 W to 5000 W or more are being implemented in various fields. Often, laser measurement is be used to monitor the performance of laser systems. Typically, these measurements, which include beam profiling, spectral observations, temporal observations, or intensity observations are performed by creating a sample of the intensity map at a plane transverse to the propagation axis of the laser beam.

[0003] While laser output measurements including beam profiling and laser beam characterization has proven useful in monitoring the performance of low power laser systems, a number of shortcomings have been identified when these systems are used to monitor the performance of high power laser systems. For example, 2-D matrix sensors such as CCD devices, CMOS devices, pyroelectric devices, and/or InGaAs devices are saturated at fluences several magnitudes less than the fluences of the output signals of the high-power laser systems under test. As a result, presently available beam profiling systems, high laser power measurement systems, and similar laser power measurement systems utilize one or more thin-film coated attenuators to reduce output signal fluence. Unfortunately, the power densities of many high-power laser system output signals exceed the damage threshold of thin-film reflective coatings used in making thin-film coated attenuators. As such, the performance of thin-film coated attenuators tends to degrade thereby permitting potentially damaging fluence to be incident on sensitive cameras and sensors used in laser beam profiling systems and/or measurement systems.

[0004] In light of the foregoing, there is an ongoing need for durable attenuator devices for use in high laser power beam profiling systems and laser beam characterization systems.

SUMMARY

[0005] The present application discloses various embodiments of a nano-textured attenuator for use with a variety of laser beam profiling systems, laser power measurement systems, and various other systems configured to measure or otherwise characterize laser output signals or beams. In one embodiment, the nano-textured attenuators disclosed herein are well-suited for use with laser outputs in excess of about 200 W to 5000 W (i.e. high power) or more, although those skilled in the art will appreciate that the various embodiments of the nano-textured attenuator disclosed herein may be used at any variety of laser powers.

[0006] In one embodiment, the nano-textured attenuator includes a body defining in in the aperture, a measurement aperture, at least one beam dump aperture. At least one coupling fixture may be formed on or positioned on the body. In one embodiment, the coupling fixture is positioned proximate to the measurement aperture. A first nano-textured beamsplitter is positioned within the body. During use, the first nano-textured beamsplitter is configured to transmit 85% to 99.9999% of an input signal therethrough while reflecting 0.0001% to form at least one partially attenuated signal. At least a second nano-textured beamsplitter is positioned within the body. During use, the second nano-textured beamsplitter is configured to transmit 85% to 99.9999% of an input signal therethrough while reflecting 0.0001% to form at least one attenuated measurement signal. At least one camera communication with the measurement aperture be configured to measure at least one optical characteristic of the attenuated measurement signal.

[0007] In another embodiment, the nano-textured attenuator includes a body defining in in the aperture, a measurement aperture, at least one beam dump aperture. At least one coupling fixture may be formed on or positioned on the body. In one embodiment, the coupling fixture is positioned proximate to the measurement aperture. A nano-textured beamsplitter is positioned within the body. During use, the nano-textured beamsplitter is configured to transmit 85% to 99.9999% of an input signal therethrough while reflecting 0.0001% to form at least one partially attenuated signal. A at least one nano-textured optical component is positioned within the body. During use, the nano-textured optical component is configured to transmit 85% to 99.9999% of the partially attenuated signal therethrough while reflecting 0.0001% to form at least one attenuated measurement signal. At least one camera communication with the measurement aperture be configured to measure at least one optical characteristic of the attenuated measurement signal.

[0008] In still another embodiment, the present application discloses a nano-textured attenuator which includes a body defining in in the aperture, a measurement aperture, at least one beam dump aperture. At least one coupling fixture may be formed on or positioned on the body. In one embodiment, the coupling fixture is positioned proximate to the measurement aperture. A first nano-textured beamsplitter is positioned within the body. During use, the first nano-textured beamsplitter is configured to transmit 85% to 99.9999% of an input signal therethrough while reflecting 0.0001% to form at least one partially attenuated signal. At least a second nano-textured beamsplitter is positioned within the body. During use, the second nano-textured beamsplitter is configured to transmit 85% to 99.9999% of an input signal therethrough while reflecting 0.0001% to form at least one attenuated measurement signal. At least one attenuator/filter body having at least filter coupled thereto may be selectively positionable within the optical beam path of the attenuated measurement signal. Thereafter, at least one camera communication with the measurement aperture be configured to measure at least one optical characteristic of the attenuated measurement signal

[0009] the present application also discloses a method of measuring high laser power optical signal which includes directing at least one input laser signal to a first nano-textured beamsplitter. A portion of the input laser signal is reflected with the first nano-textured beamsplitter to form at least one partially attenuated signal. The partially attenuated signal has 0.0001% to 15% of the power of the laser input signal while transmitting 85% to 99.9999% of the laser input signal through the first nano-textured beamsplitter. Thereafter, a portion of the partially attenuated signal from the first nano-textured beamsplitter is reflected by at least a second nano-textured beamsplitter to form at least one attenuated measurement signal. The attenuated measurement signal has 0.0001% to 15% of the power of the partially attenuated signal while transmitting 85% to 99.9999% of the laser input signal through the second nano-textured beamsplitter. Finally, at least one optical characteristic of the attenuated measurement signal may be measured with at least one sensor system.

13. The method of claim **12** further comprising selectively inserting at least one attenuator/filter body between at least one of the first nano-textured beamsplitter, the second nano-textured beamsplitter, and the at least one sensor system.

[0010] Other features and advantages of the nano-textured attenuator for use with laser beam profiling and laser beam characterization systems as described herein will become more apparent from a consideration of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The novel aspects of the embodiments of a nano-textured attenuator for use with laser beam profiling laser beam characterization systems as disclosed herein will be more apparent by consideration of the following figures, wherein:

[0012] FIG. **1** shows an elevated perspective view of an embodiment of a nano-textured attenuator for with laser beam profiling and laser beam characterization systems;

[0013] FIG. **2** shows alternate elevated perspective view of an embodiment of the nano-textured attenuator for use with laser beam profiling and laser beam characterization systems;

[0014] FIG. **3** shows a planar side view of an embodiment of a nano-textured attenuator having a camera system coupled thereto for use with laser beam profiling and laser beam characterization systems;

[0015] FIG. **4** shows an elevated perspective view of an embodiment of a nano-textured attenuator having a camera system coupled thereto for use with laser beam profiling and laser beam characterization systems;

[0016] FIG. **5** shows a schematic diagram of the internal components of an embodiment of a nano-textured attenuator for use with laser beam profiling and laser beam characterization systems; and

[0017] FIG. **6** shows a schematic diagram of the internal components of another embodiment of a nano-textured attenuator for use with laser beam profiling and laser beam characterization systems.

DETAILED DESCRIPTION

[0018] The present application discloses various embodiments of a nano-textured attenuator for use with a variety of laser beam profiling systems, laser power measurement systems, and various other systems configured to measure or otherwise characterize laser output signals or beams. In one embodiment, the nano-textured attenuator disclosed herein is well-suited for use with laser outputs in excess of about 200 W to 5000 W (i.e. high power) or more, although those skilled in the art will appreciate that the various embodiments of the nano-textured attenuator disclosed herein may be used at any variety of laser powers. Further, those skilled in the art will appreciate that the physical dimensions and configuration of the embodiments of the nano-textured attenuator disclosed herein are intended to illustrate the operation of the nano-textured attenuator and are not intended to limit the components and characteristics of the nan-textured attenuator to those embodiments disclosed.

[0019] FIGS. **1-4** show various views of an embodiment of a nano-textured attenuator for use with laser beam profiling systems, laser measurements systems, and similar laser beam characterization systems. In the illustrated embodiment, the nano-textured attenuator **10** includes a body **12** having at least one input aperture **14** formed therein. In the illustrated embodiment, a single input aperture **14** is formed in the body **12**, although those skilled in the art will appreciate that any number of input apertures **14** may be formed on the body **12**. Further, the input aperture **14** may be formed on any surface of the body **12**. Optionally, the input aperture **14** may be formed having any variety of transverse dimensions, shapes, or configurations. Further, the input aperture **14** may include one or more windows or protective elements enclosing the input aperture **14**. Optionally, input aperture **14** not include one or more protective windows.

[0020] Referring again to FIGS. **1-4**, at least one coupling fixture **16** may be formed on or couple to the body **12**. In the illustrated embodiment, the coupling fixture **16** defines at least one profiling and/or measurement aperture or characterization aperture **18** (hereinafter measurement aperture **18**) therein. Like the input aperture **14**, the measurement aperture **18** may or may not include at least one protective window. Optionally, any number of measurement apertures **18** may be formed on or positioned proximate to the coupling fixture **16**. Further, the coupling fixture **16** may include at least one coupling member or feature **20** thereby permitting one or more cameras, sensors, characterization systems, or similar devices to be coupled to the body **12** of the nano-textured attenuator **10**. In one embodiment, the coupling member **20** comprises one or more thread features permitting one or more cameras, sensors, characterization systems, or similar devices to be selectively coupled to and/or detached from the body **12** of the nano-textured attenuator **10** and threaded relation. Those skilled in the art will appreciate that any variety of coupling members **20** or similar coupling features may be used to selectively couple and/or detach one or more cameras, sensors, characterization systems, or similar devices to the body **12** of the nano-textured attenuator **10** disclosed herein. In another embodiment, the coupling member **20** may be configured to couple one or more fiber-optic devices or other systems to the body **12**. Optionally, the coupling feature **16** may be configured to have one or more cameras, sensors, characterization systems, or similar devices non-detachably coupled to the body **12**. For example, at least one camera, sensor, characterization system, or similar device may be integrally formed on or within the body **12** of the nano-textured attenuator **10**. As such, the coupling fixture **16** need not include a coupling member **20**.

[0021] As shown in FIGS. **1-4**, the nano-textured attenuator **10** may include one or more attenuator or filter bodies configured to be selectively inserted into and withdrawn from at least one beam path formed within the body **12**. As shown, the attenuator filter bodies may be positioned between the input aperture **14** and the measurement aperture **18**. In the illustrated embodiment, a first attenuator/filter body **22** and a second attenuator/filter body **26** may be selectively inserted into withdrawn from the body **12**. Those skilled in the art will appreciate the any number of attenuator/filter bodies may be used in the embodiments of the nano-textured attenuator **10** disclosed herein. As shown in FIG. **1**, the first attenuator/filter body **22** includes at least a first filter receiver **24** form thereon and configured to receive and retain at least a first filter or optical component therein. Similarly, as shown in FIG. **2**, at least a second filter receiver **28** may be formed in or coupled to the second attenuator/filter body **26**. Like the first filter receiver **24**, the second filter receiver **28** may be configured to receive and retain at least one filter or optical component therein. For example, the first filter receiver **24** and/or the second filter receiver **20** may be configured to receive and retain at least one attenuator, optical component, filter, polarizer, wave plate, diffuser, or similar device therein. For example, in one embodiment at least one of the first filter **24** and the second filter **28** may comprise at least one thin film coated optical filter therein. During use, the first attenuator/filter body **22** and/or the second attenuator/filter body **26** may be selectively inserted into or withdrawn from at least one optical pathway formed within the body **12**. As such, filters or optical components retained by the first attenuator/filter body **22** and/or the second attenuator/filter body **26** may be inserted into withdrawn from at least one optical pathway formed within the body **12**. In the illustrated embodiment, the first attenuator/filter body **22** and the second attenuator/filter body **26** may be manually actuated. Optionally, at least one of the first attenuator/filter body **22** and the second attenuator/filter body **26** may include one or more mechanical actuators permitting autonomous insertion and withdrawal of at least one of the first attenuator/filter body **22** and the second attenuator/filter body **26** from the body **12**.

[0022] As shown in FIGS. **2**-**4**, one or more beam dump passages or apertures may be formed on the body **12**. For example, as shown in FIGS. **2** and **4**, a first beam dump aperture **30** may be formed on the body **12**, while FIG. **3***b* shows a second beam dump aperture **32** formed on the body **12**. As such, in the embodiments shown in FIGS. **2**-**4**, the nano-textured attenuator **10** includes a first beam dump aperture **30** and at least a second beam dump aperture **32** formed on the body **12**. Those skilled in the art will appreciate that any number of beam dump apertures may be formed on the body **12** of the nano-textured attenuator **10**. During use, the first beam dump aperture **30** and the second beam dump aperture **32** may be configured to permit at least one output beam to be transmitted or emitted therefrom. As such, the first beam dump aperture **30** may be configured to be positioned proximate to at least one beam dump (not shown). Similarly, the second beam dump aperture **32** may likewise be configured to be positioned proximate to at least a second beam dump (not shown). In another embodiment, at least one of the first beam dump aperture **30** and the second beam dump aperture **32** may be configured to transmit or otherwise emit at least one output beam from the body **12**.

[0023] As described above, the nano-textured attenuator **10** may be configured to be coupled to and/or be positioned proximate to at least one camera, sensor, characterization system, or similar device. FIGS. **3***a*, **3***b*, and **4** show various views of an embodiment of a nano-textured attenuator **10** having one or more cameras, sensors, characterization systems, or similar devices **40** coupled thereto. As shown, in one embodiment, the camera **40** includes a first camera body **42** and a second camera body **44**. At least one camera coupling device or system **46** may be coupled to or formed on at least one of the first camera body **42** in the second camera body **44**. During use, the camera coupling device **46** may be configured to selectively engage and be retained by the coupling member **20** formed on the coupling fixture **16** of the body **12** (see FIG. **1**). Optionally, the camera coupling device **46** may be configured to selectively engage in coupled to a portion of the body **12** such that at least a portion of the camera **40** is in communication with the measurement aperture **18** formed in the body **12**. Optionally, the camera **40** need not be detachable from the body **12**. In the illustrated embodiment, the camera **40** includes at least one output and/or data coupler **48**, thereby permitting measurement or characterization data recorded by the camera **40** to be provided to at least one external processor (not shown). Those skilled in the art will appreciate that any variety of camera systems or devices may be used with a couple to the body **12** of the nano-textured attenuator **10**. Exemplary camera systems or devices include, without limitation, 2-D matrix sensors, CCD devices, CMOS devices, InGaAs devices, polarization sensor or measuring devices, spectral or temporal measurement devices, power meters, and the like.

[0024] FIG. **5** shows the internal components of an embodiment of a nano-textured attenuator. As shown in FIG. **5**, a first nano-textured beamsplitter or prism **50** and at least a second nano-textured beamsplitter **52** may be positioned within the body **12**, although those skilled in the art will appreciate that any number of nano-textured beamsplitters, prisms, or alternate nano-textured optical elements may be positioned within the body **12**. In one embodiment, at least one of the first nano-textured beamsplitter **50** and the second nano-textured beamsplitter **52** may be positioned on at least one selectively adjustable optical mount. As such, the position and/or orientation of at least one of the first nano-textured beamsplitter **50** and/or the second nano-textured beamsplitter **52** may be selectively adjusted by a user. Optionally, at least one of the first nano-textured beamsplitter **50** and the second nano-textured beamsplitter **52** may be positioned on fixed optical mounts such that the position and/or orientation of the first nano-textured beamsplitter **50** and/or the second nano-textured beamsplitter **52** is fixed.

[0025] As shown in FIG. **5**, during use an input beam **70** may be directed into the body **12** of the nano-textured attenuator **10** via the input aperture **14**. The input beam **70** may be incident on a portion of the first nano-textured beamsplitter **50** positioned within the body **12**. As a result, a portion of the input beam **70** may be reflected or otherwise or otherwise directed by the first nano-textured beamsplitter **50** to form a partially attenuated beam **74** which is directed within the body **12**. In one embodiment, at least one of the first and second nano-textured beamsplitters **50**, **52** are manufactured from Corning™ 7980 Grade OF UV fused silica having undergone one or more nano-texturing processes, although those skilled in the art will appreciate that any variety of substrates may be used to form the of the first and second nano-textured beamsplitters **50**, **52**. Optionally, one or more thin film coatings may also be applied to at least one of the first and second nano-textured beamsplitters **50**, **52**. Exemplary thin film coatings include AR coatings and the like. Further, a portion of the input beam **70** is transmitted through the first nano-textured beamsplitter **50** to form a first output beam **72**. In the illustrated embodiment, the first output beam **72** may be emitted from the body **12** via the first beam dump aperture **30**. In one embodiment, the first nano-textured beamsplitter **50** is configured to transmit approximately 95% to about 99.9999% the power and/or fluence of the input beam **70** there through. As such, the first output beam **72** encompasses approximately 95% to about 99.9999% the power and/or fluence of the input beam **70**, which may be directed to one or more external beam dumps (not shown). As such, the partially attenuated beam **74** traversing through the body **12** encompasses approximately 5% to about 0.1% or less of the power and/or fluence of the input beam **70**.

[0026] Referring again to FIG. **5**, at least a portion of the partially attenuated beam **74** may be incident on a portion of the second nano-textured beamsplitter **52** positioned within the body **12**. Like the first nano-textured beamsplitter **50**, the second nano-textured beamsplitter **52** is configured to transmit approximately 95% to about 99.9999% the power and/or fluence of an incident optical signal there through. As such, approximately 95% to about 99.9999% the power and/or fluence of the partially attenuated beam **74** incident on the second nano-textured beamsplitter **52** is transmitted there through to form a second output beam **76**. In one embodiment, the second output beam **76** is directed through the second beam dump aperture **32** two one or more external beam dumps (not shown). Further, approximately 5% to about point one percent 0.1 or less of the power and/or fluence of the partially attenuated beam **74** may be directed by the second nano-textured beamsplitter **52** to form at least one attenuated measurement beam **78** directed to the camera/sensor **40** coupled to the body **12**. In one embodiment, the attenuated measurement beam **78** encompasses approximately 0.25% to about 0.001% or less of the power and/or fluence of the input beam **70**. In another embodiment, the attenuated measurement beam **78** encompasses approximately 0.000001% or less of the power and/or fluence of the input beam **70**. Those skilled in your will appreciate that the transmission characteristics of the first nano-textured beamsplitter **50** and second nano-textured beamsplitter **52** may range from about 85% to about 99.99999% transmission of an incident optical signal. As such, and optical signal reflected by at least one of the first nano-textured beamsplitter **50** and the second nano-textured beamsplitter **52** may contain about 15% to about 0.00001% or less of the power and/or fluence of an incident optical signal.

[0027] As shown in FIG. **5**, as stated above, the attenuated measurement beam **78** may be directed to the camera/sensor **40** coupled to the body **12**. Optionally, the attenuated measurement beam **78** may traverse through at least one of the first attenuator/filter body **22** in/or the second attenuator/filter body **26** to further attenuate or otherwise filter the attenuated measurement beam **78**.

[0028] Optionally, the nano-textured attenuator **10** may include a single nano-textured beamsplitter, prism, or optical element within the body **12**. For example, FIG. **6** shows an alternate embodiment of a nano-textured attenuator **10** having a single nano-textured beamsplitter **50** within the body **12**. Like the previous embodiment, the first nano-textured beamsplitter **50** is configured to transmit approximately 95% to about 99.9999% the power and/or fluence of the input beam **70** there through. As such, the first output beam **72** encompasses approximately 95% to about 99.9999% the power and/or fluence of the input beam **70**, which may be directed to one or more external beam dumps (not shown). As such, the partially attenuated beam **74** traversing through the body **12** encompasses approximately 5% to about 0.1% or less of the power and/or fluence of the input beam **70**.

[0029] Referring again to FIG. **6**, at least a portion of the partially attenuated beam **74** may be incident on a portion of at least one optical component **54** positioned within the body **12**. In one embodiment, the optical component **54** comprises one or more lenses, beamsplitters, wave plates, polarizers, and the like. Further, the optical component **54** may include one or more optical coatings **56** applied thereto. Exemplary optical coatings **56** include, without limitation, anti-reflection (AR) coatings, thin-film coatings, and the like. Optionally, the optical component **54** may comprise a nano-textured substrate, a grating, or a similar optical component. The optical component **54** may be configured to transmit approximately 95% to about ninety-nine point nine percent 99.9999% the power and/or fluence of an incident optical signal there through. As such, approximately 95% to about 99.9999% the power and/or fluence of the partially attenuated beam **74** incident on the optical component **54** is transmitted there through to form a second output beam **76**. In one embodiment, the second output beam **76** is directed through the second beam dump aperture **32** two one or more external beam dumps (not shown). Further, approximately 5% to about 0.1% or less of the power and/or fluence of the partially attenuated beam **74** may be directed by the optical component **54** to form an attenuated profiling/measurement beam **78** which may be directed to the camera/sensor **40** coupled to the body **12**. In one embodiment, the attenuated measurement beam **78** encompasses approximately 0.25% to about 0.001% or less of the power and/or fluence of the input beam **70**. In another embodiment, the attenuated measurement beam **76** encompasses approximately 0.000001% or less of the power and/or fluence of the input beam **70**. Those skilled in your will appreciate that the transmission characteristics of the first nano-textured beamsplitter **50** and the optical component **54** may range from about 85% to about 99.99999% transmission of an incident optical signal. As such, and optical signal reflected by at least one of the first nano-textured beamsplitter **50** and the optical **54** may contain about 15% to about 0.00001% or less of the power and/or fluence of an incident optical signal.

[0030] It is appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of various features described hereinabove as well as variations and modifications thereto which would occur to a person of skill in the art upon reading the above description and which are not in the prior art.

What is claimed:

1. A nano-textured attenuator for use in laser beam characterization systems, comprising:

a body defining at least one input aperture, at least one measurement aperture, and at least one beam dump aperture;

at least one coupling fixture positioned on the body, the coupling fixture positioned proximate to the at least one measurement aperture;

a first nano-textured beamsplitter positioned within the body, the first nano-textured beamsplitter configured to transmit 85% to 99.9999% of an input signal therethrough and reflect 15% to 0.0001% of the input signal to form at least one partially attenuated signal;

at least a second nano-textured beamsplitter positioned within the body, the second nano-textured beamsplitter configured to transmit 85% to 99.9999% of the partially attenuated signal therethrough and reflect 15% to 0.0001% of the partially attenuated signal to form at least one attenuated measurement signal; and

at least one camera system coupled to the body, the at least one camera system configured to receive the at least one attenuated measurement signal and measure at least one characteristics of the at least one attenuated measurement signal.

2. The nano-textured attenuator of claim **1** further comprising at least one attenuator/filter body configured to receive and retain at least one attenuator or optical filter therein, the at least one attenuator/filter body configured to be selectively positionable within the body between at least one input aperture and at least one measurement aperture.

3. The nano-textured attenuator of claim **2** further comprising:

a first attenuator/filter body having at least a first filter coupled thereto, the first attenuator/filter body selectively positionable within an optical beam path of the at least one attenuated measurement signal; and

a second attenuator/filter body having at least a second filter coupled thereto, the second attenuator/filter body selectively positionable within an optical beam path of the at least one attenuated measurement signal.

4. The nano-textured attenuator of claim **1** further comprising at least one selectively movable mount configured to adjustably support at least one of the first nano-textured beamsplitter and the second nano-textured beamsplitter.

5. The nano-textured attenuator of claim **1** wherein at least one of the at least one input aperture, at least one measurement aperture, and at least one beam dump aperture includes protective window.

6. A nano-textured attenuator for use in laser beam characterization systems, comprising:

a body defining at least one input aperture, at least one measurement aperture, and at least one beam dump aperture;

at least one coupling fixture positioned on the body, the coupling fixture positioned proximate to the at least one measurement aperture;

a nano-textured beamsplitter positioned within the body, the nano-textured beamsplitter configured to transmit 85% to 99.9999% of an input signal therethrough and reflect 15% to 0.0001% of the input signal to form at least one partially attenuated signal;

at least one nano-textured optical element positioned within the body, the at least one nano-textured optical element configured to transmit 85% to 99.9999% of the partially attenuated signal therethrough and reflect 15% to 0.0001% of the partially attenuated signal to form at least one attenuated measurement signal; and

at least one camera system coupled to the body, the at least one camera system configured to receive the at least one attenuated measurement signal and measure at least one characteristics of the at least one attenuated measurement signal.

7. The nano-textured attenuator of claim **6** further comprising at least one attenuator/filter body configured to receive and retain at least one attenuator or optical filter therein, the at least one attenuator/filter body configured to be selectively positionable within the body between at least one input aperture and at least one measurement aperture.

8. The nano-textured attenuator of claim **7** further comprising:

a first attenuator/filter body having at least a first filter coupled thereto, the first attenuator/filter body selectively positionable within an optical beam path of the at least one attenuated measurement signal; and

a second attenuator/filter body having at least a second filter coupled thereto, the second attenuator/filter body selectively positionable within an optical beam path of the at least one attenuated measurement signal.

9. The nano-textured attenuator of claim **6** further comprising at least one selectively movable mount configured to adjustably support at least one of the nano-textured beamsplitter and the at least one nano-textured optical element.

10. The nano-textured attenuator of claim **6** wherein at least one of the at least one input aperture, at least one measurement aperture, and at least one beam dump aperture includes protective window.

11. A nano-textured attenuator for use in laser beam characterization systems, comprising:

a body defining at least one input aperture, at least one measurement aperture, and at least one beam dump aperture;

at least one coupling fixture positioned on the body, the coupling fixture positioned proximate to the at least one measurement aperture;

a first nano-textured beamsplitter positioned within the body, the first nano-textured beamsplitter configured to transmit 85% to 99.9999% of an input signal therethrough and reflect 15% to 0.0001% of the input signal to form at least one partially attenuated signal;

at least a second nano-textured beamsplitter positioned within the body, the second nano-textured beamsplitter configured to transmit 85% to 99.9999% of the partially attenuated signal therethrough and reflect 15% to 0.0001% of the partially attenuated signal to form at least one attenuated measurement signal;

at least one camera system coupled to the body, the at least one camera system configured to receive the at least one attenuated measurement signal and measure at least one characteristics of the at least one attenuated measurement signal;

a first attenuator/filter body having at least a first filter coupled thereto, the first attenuator/filter body selectively positionable within an optical beam path of the at least one attenuated measurement signal; and

a second attenuator/filter body having at least a second filter coupled thereto, the second attenuator/filter body selectively positionable within an optical beam path of the at least one attenuated measurement signal.

12. A method of measuring high laser power optical signal comprising:

directing at least one input laser signal to a first nano-textured beamsplitter;

reflecting a portion of the input laser signal with the first nano-textured beamsplitter to form at least one partially attenuated signal, the at least one partially attenuated signal having 0.0001% to 15% of the power of the laser input signal while transmitting 85% to 99.9999% of the laser input signal through the first nano-textured beamsplitter;

reflecting a portion of the at least one partially attenuated signal from the first nano-textured beamsplitter with at least a second nano-textured beamsplitter to form at least one attenuated measurement signal, the at least one attenuated measurement signal having 0.0001% to 15% of the power of the at least one partially attenuated signal while transmitting 85% to 99.9999% of the laser input signal through the second nano-textured beamsplitter; and

measuring at least one optical characteristic of the at least one attenuated measurement signal with at least one sensor system.

13. The method of claim **12** further comprising selectively inserting at least one attenuator/filter body between at least one of the first nano-textured beamsplitter, the second nano-textured beamsplitter, and the at least one sensor system.

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