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(54) Title of the Invention WHITE PULSED LIGHT GENERATING APPARATUS

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SPECIFICATION

1. Title of the Invention

WHITE PULSED LIGHT GENERATING APPARATUS

2. Claims

(1) A white pulsed light generating apparatus in which a metal which readily emits electrons is provided in a transparent container, the container containing a gas therein and being irradiation target means, and the electron-emitting metal is irradiated with light having a high light intensity to cause predetermined white pulsed light to be generated from the electron-emitting metal, wherein separating means for separating the white pulsed light emitted from the electron-emitting metal is provided in substantially the same direction as an incident direction of the light having a high light intensity.

(2) The white pulsed light generating apparatus according to claim (1), wherein the separating means is constituted by a beam sampler which reflects the light

having a high light intensity to irradiate the electron-emitting metal and transmits the white-pulsed light generated at the electron-emitting metal.

(3) The white pulsed light generating apparatus according to claim (2), wherein the beam sampler is formed by vapor-depositing ZrO_2, SiO_2 onto a quartz substrate, the beam sampler reflecting approximately 100% of a laser of 1064 nm, being the light having a high light intensity, and transmitting approximately 100% of the generated white pulsed light.

(4) The white pulsed light generating apparatus according to claim (1), (2) or (3), wherein a lens having a short focal length for focusing the light having a high light intensity onto the electron-emitting metal is inserted between the separating means and the irradiation target means,

(5) The white pulsed light generating apparatus according to claim (1), wherein the separating means has a passage hole for allowing the light having a high light intensity for irradiating the electron-emitting metal to pass therethrough, the separating means being constituted by a reflecting mirror which reflects the generated white pulsed light.

3. Detailed Description of the Invention

[Technical Field of the Invention]

The present invention relates to a white pulsed light generating apparatus for obtaining white pulsed light with a high luminance.

[Prior Art]

It is known that irradiation of an electrode (cathode) in a xenon lamp to which no voltage is applied with, for example, a YAG laser of a fundamental wavelength (1064 nm) causes white pulsed light with a high luminance to be generated. This white pulsed light is used, for example, as probe light in a time-resolved absorption measuring apparatus which uses a streak camera as a detector.

In the time-resolved absorption apparatuses of this type, as shown in Fig. 5, a sample (10) is irradiated with excitation light (9) of a laser pulse, and the spectra and changes in the strength of excited species and reaction intermediates generated in the sample (10) are tracked using white probe light (11) which is white light having a continuous spectrum, where the changes in the strength of the probe light (11) are detected by a streak camera (12) to observe the transient absorption spectrum and changes in its strength.

As shown in Fig. 5, a generating apparatus for the white probe light (11): uses

a lens (1) to focus light having a high light intensity, e.g., a YAG laser of a fundamental wavelength (1064 nm), onto a front side of a cathode (4) in a xenon lamp (3), being irradiation target means, to generate white light (5); extracts the generated white light (5); collects the light using a lens (6); and sends the light via an optical fiber (7) to the sample (10).

[Problem to be Solved by the Invention]

When the incident laser (2) is focused onto the cathode (4) in the xenon lamp (3) as described above, the white pulsed light is generated from the cathode (4). The white pulsed light is emitted with a high intensity particularly in a plane (13) (the hatched portion in Fig. 5) in substantially the same path as the incident path of the laser (2). However, since it has been structurally impossible to extract the white pulsed light from the same path as the incident path of the laser (2) in the related art, there has been no other way but to extract the white pulsed light from a lateral side thereof, as shown in Fig. 5.

It is an object of the present invention to provide an apparatus capable of extracting highly-efficient white pulsed light from a portion where it is emitted with a high intensity in substantially the same path as the incident path of the light having a high light intensity and further capable of preventing damage from the incident light as a result of the above configuration.

[Means for Solving the Problem]

The present invention provides an apparatus in which a metal which readily emits electrons is provided in a transparent container, the container containing a gas therein and being irradiation target means, and the electron-emitting metal is irradiated with light having a high light intensity to cause predetermined white pulsed light to be generated from the electron-emitting metal, wherein separating means for separating the white pulsed light emitted from the electron-emitting metal is provided in substantially the same direction as an incident direction of the light having a high light intensity.

[Effect]

If a laser is used as the light having a high light intensity, the beam diameter of the incident laser should first be expanded to a maximum extent. By providing a lens having a short focal length, the laser with such large beam diameter is transmitted through a portion in the glass surface in the xenon lamp in such a state that the beam diameter is expanded to a maximum extent to thereby minimize damage to the glass surface portion. The transmitted laser is focused onto the cathode in the xenon lamp and white light is generated at the cathode.

Only white pulsed light emitted in substantially the same path as the incident path of the laser, from among the generated white pulsed light, is separated by the separating means and sent to the next stage via an optical fiber.

[Embodiments of the Invention]

An embodiment of the present invention will be described below with reference to the attached drawings.

In Fig. 1, reference numeral (2) denotes light having a high light intensity, e.g., a laser pulse having a fundamental wavelength of 1064 nm, 30 ps and 30 mJ generated by an Nd:YAG laser apparatus. This laser (2) is allowed to be incident on a cathode (4), being an electron-emitting metal, and light emitted by the cathode (4) is sent to separating means for separating it from the laser (2), i.e., a beam sampler (8) such as a dichroic mirror. This beam sampler (8) is formed by vapor depositing approximately 16 layers of ZrO_2, SiO_2 onto a quartz substrate. Such beam sampler (8) is formed so as to have the property of reflecting approximately 100% of light of around 1064 nm and transmitting approximately 100% of the visible light range as shown in Fig. 2 and so as to further have a high optical damage threshold. The laser (2) reflected by the beam sampler (8) irradiates, through a lens (1), the electrode (cathode) (4) in the xenon lamp (3), being irradiation target means. At this time, if a glass surface (14) of the xenon lamp (3) has a large radius, the glass surface (14) will not suffer from damage. However, if the glass surface (14) has a small radius, the lens (1) is configured to be aspheric so as to have a short focal length and is placed as close as possible to the xenon lamp (3), so that the laser (2) can be transmitted through the glass surface (14) of the xenon lamp (3) in such a state that its beam diameter has first be expanded, to thereby minimize damage to the glass surface (14). When the laser (2) is focused onto the cathode (4) in the xenon lamp (3), white pulsed light (5) is generated at substantially the whole circumference of the cathode (4). Since the white pulsed light (5) in a plane which is the same as the plane of incidence of the laser (2), from among the generated white pulsed light (5), is emitted with the highest intensity, the white pulsed light (5) in the same path as the incident path is collected. The collected light is allowed to pass through the lens (1) again and turned into parallel light beams. The beam sampler (8) transmits approximately 100% of the visible light range of the white pulsed light (5) and the transmitted white pulsed light (5) is further focused by the lens (6) into an optical fiber (7) and sent to the next stage by the optical fiber (7).

Although the above embodiment has described an example in which the cathode (4) in the xenon lamp (3) is irradiated with the laser (2) to obtain the white pulsed light (5), the present invention is not limited thereto. Specifically, a sealed transparent container may be used as the glass tube, the transparent container being filled with an inert gas such as xenon, and as a metal which readily emits electrons in the container, tungsten containing alkali metals or alkali earth metals such as, for example, barium or thorium may be used. In addition, the irradiation light source may not necessarily be a laser and may employ any light having a high light intensity. The gas filling the tube may also be krypton other than the xenon. However, the use of krypton would produce a slightly reddish pulsed light.

Although the above embodiment employs the beam sampler (8) as separating means for refracting the light having a high light intensity so as to be incident on the electron-emitting metal (4) and for transmitting the white pulsed light (5), other examples will be described with reference to Figs. 3 and 4.

In Fig. 3, the separating means is constituted by a planar reflecting mirror (8) and a lens (6), where the light having a high light intensity is allowed to pass through a passage hole (15) at the center of the planar reflecting mirror (8) to irradiate the electron-emitting metal (4) in the transparent container (14). Since the beam diameter at this point in time is small, this configuration should be employed only when the light does not cause damage to the glass surface (14) when passing through the transparent container (14). The generated white pulsed light (5) is reflected by the planar reflecting mirror (8) and focused by the lens (6) into the optical fiber (7).

Note that the separating means constituted by the planar reflecting mirror (8) and the lens (6) may be replaced with that employing a concave mirror (8), as shown in Fig. 4.

[Effect of the Invention]

Since the present invention has the configurations as described above, the white pulsed light can be efficiently collected at the portion where it is emitted with the highest intensity. In addition, the provision of a lens with a short focal length can allow the beam having a large diameter to be transmitted through the glass surface and can thus prevent damage to the glass surface.

4. Brief Descriptions of the Drawings

Fig. 1 is a diagram for illustrating a first embodiment of a white pulsed light

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