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(54) [Title of the Invention] LIGHT RADIATION APPARATUS

(57) [Abstract]

[Object] To achieve a continuous high-power point light source of ultraviolet light and visible light regardless of the electrodes' lifetime.

[Solving Means] A light radiation apparatus is provided in which: electromagnetic radiation with a wavelength of 0.1 mm-10 mm is temporarily diverged and then converged; plasma is generated from a gas that is present near a convergent point of such electromagnetic radiation so as to cause light to be emitted; and the emitted light is collected using reflecting mirrors.

[Claims]

1. A light radiation apparatus wherein: electromagnetic radiation with a wavelength of 0.1 mm-10 mm is temporarily diverged and then converged; plasma is generated from a gas that is present near a convergent point of the electromagnetic radiation so as to cause light to be emitted; and the emitted light is collected using a reflecting mirror.

2. The light radiation apparatus according to claim 1, wherein the gas for light emission comprises a noble gas as its main constituent.

3. The light radiation apparatus according to claim 1 or 2, wherein the gas for light emission is supplied so as to provide a flow thereof around a focal position of converging electromagnetic radiation.

4. The light radiation apparatus according to claim 1 or 2, wherein the gas for light emission is sealed in an airtight container through which converging electromagnetic radiation and radiation pass.

5. The light radiation apparatus according to claim 4, wherein the gas for light emission contains any of: a metal selected from among mercury, zinc and indium; metallic halide; and sulfur.

6. The light radiation apparatus according to any of claims 1 to 5, wherein an electromagnetic radiation absorber is provided on a side opposite to an electromagnetic-radiation introduction side with respect to a convergent position of electromagnetic radiation.

7. The light radiation apparatus according to any of claims 1 to 5, wherein an electromagnetic radiation reflector is provided on a side opposite to an electromagnetic-radiation introduction side with respect to a convergent position of electromagnetic radiation.

8. The light radiation apparatus according to any of claims 1 to 7, wherein a startup auxiliary-antenna is provided around an area in which electromagnetic radiation is converged and in which a gas discharge is performed near a focal position of the electromagnetic radiation.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

The present invention relates to a point radiation source of visible radiation and ultraviolet radiation, and particularly relates to a high-power point radiation source of ultraviolet radiation.

[0002]

[Prior Art]

In the field of electronics industry involving semiconductors and liquid crystals, ultraviolet exposure is performed so as to carry out an exposure to transfer a minute circuit pattern to a semiconductor substrate or liquid crystal substrate, and an ultraviolet light source having a point light source is used as a light source apparatus for such exposure. In recent years, there have been increasing market demands for increased exposure area size and for increased throughput of production lines. Under present circumstances, a mercury lamp utilizing light emission from mercury vapor is used as a large-area exposure ultraviolet light source. Such mercury lamp is a discharge lamp in which a pair of high-melting-point metal electrodes is arranged in a quartz glass bulb, and in which not less than several mg to several tens of mg/cc of mercury and, as a buffer gas, a noble gas such as argon, are sealed in such bulb. However, such lamp includes electrodes, and thus, the power limit is considered to be 10 kW. This is because an anode electrode from among the above electrodes is heated and evaporated, leading to a reduction of radiated light due to blackening of the inside of the bulb and to melting of electrodes, whereby it becomes impossible for a discharge itself to be maintained.

[0003]

Further, plasma emission through the use of a laser has been considered. However, such plasma emission involves low laser-energy conversion efficiency and has not been put into practical use. Further, a light source of microwave excitation such as an electrodeless lamp has been discussed but the situation is such that it is difficult to achieve a point light source using the above light source of microwave excitation. The reasons for this are that a microwave has a long wavelength of 1 cm or more and thus cannot be concentrated to around its wavelength or less and point plasma cannot be produced from microwaves.

[0004]

A point light source of visible light has also been desired to provide increased power. For the purpose of weathering tests, a xenon lamp is currently being used for applications involving fibers and solar-cell large-area uniform radiation. However, such increased power remains at the level of 7 kW. As to high-power visible light sources, there is a light emitting source named a “vortex arc”; however, such light emitting source has disadvantages in that it frequently requires electrode replacement and involves troublesome maintenance.

[0005]

Recently, regarding millimeter/submillimeter wave generation apparatuses, the millimeter/submillimeter wave conversion efficiency with respect to input power has seen remarkable improvements. For example, a millimeter/submillimeter wave generation apparatus named "gyrotron" is attracting attention as an apparatus whose conversion efficiency with respect to input power reaches 50%. An example of a gyrotron is shown in, for example, *Oyo Buturi*, Vol. 70, No. 3, 2001, pp. 322-326. The above reference describes the basic configuration and operation principle thereof. As opposed to microwaves, millimeter/submillimeter waves do not require a waveguide and can propagate electric power through the air. The inventor has reached the present invention as a result of intensive studies on the application of such millimeter/submillimeter wave generation apparatus to a point radiation source.

[0006]

[Problem to be Solved by the Invention]

In order to achieve the above-mentioned large-area exposure, it is desired to have an ultraviolet light source which has power of 15 kW or more and which is adapted to provide a point light source size of approximately 10 mm. Further, it is desired to have a high-power visible light source with power of 20 kW or more for light-resistance test applications. In view of this, an object of the present invention is to achieve a point light source that is capable of performing continuous high-power optical radiation regardless of the electrodes' lifetime.

[0007]

[Means for Solving the Problem]

In order to attain the above object, the invention according to claim 1 provides a light radiation apparatus wherein: electromagnetic radiation with a wavelength of 0.1 mm-10 mm is temporarily diverged and then converged; plasma is generated from a gas that is present near a convergent point of the electromagnetic radiation so as to cause light to be emitted; and the emitted light is collected using a reflecting mirror.

[0008]

The invention according to claim 2 provides the light radiation apparatus according to claim 1, wherein the gas for light emission comprises a noble gas as its main constituent.

[0009]

The invention according to claim 3 provides the light radiation apparatus according to claim 1 or 2, wherein the gas for light emission is supplied so as to provide a flow thereof around a focal position of converging electromagnetic radiation.

[0010]

The invention according to claim 4 provides the light radiation apparatus according to claim 1 or 2, wherein the gas for light emission is sealed in an airtight container through which converging electromagnetic radiation and radiation pass.

[0011]

The invention according to claim 5 provides the light radiation apparatus according to claim 4, wherein the gas for light emission contains any of: a metal selected from among mercury, zinc and indium; metallic halide; and sulfur.

[0012]

The invention according to claim 6 provides the light radiation apparatus according to any of claims 1 to 5, wherein an electromagnetic radiation absorber is provided on a side opposite to an electromagnetic-radiation introduction side with respect to a convergent position of electromagnetic radiation.

[0013]

The invention according to claim 7 provides the light radiation apparatus according to any of claims 1 to 5, wherein an electromagnetic radiation reflector is provided on a side opposite to an electromagnetic-radiation introduction side with respect to a convergent position of electromagnetic radiation.

[0014]

The invention according to claim 8 provides the light radiation apparatus according to any of claims 1 to 7, wherein a startup auxiliary-antenna is provided around an area in which electromagnetic radiation is converged and in which a gas discharge is performed near a focal position of the electromagnetic radiation.

[0015]

[Effects]

According to the configuration of the present invention, millimeter/submillimeter waves which achieve a conversion efficiency of 50% or more with respect to an input power are temporarily diverged and then converged; plasma is generated from the millimeter/submillimeter waves at a focal position of such millimeter/submillimeter waves so as to cause light to be emitted, resulting in a point radiation source. Reflecting mirrors are provided so

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