More specifically, a first aspect of the invention ~~of~~ is a laser line beam improvement apparatus of the present invention includes: a first shielding portion that is arranged at a position relatively far from an object to be processed on an optical path of a line beam emitted to the object to be processed and that shields transmission of major axis end sections of the line beam; the line beam comprising a flat section and steepness sections positioned at minor axis end sections and the major axis sections in a beam intensity profile; and a second shielding portion that is arranged at a position relatively near the object to be processed and that further shields the transmission of the major axis end sections of the line beam after the shielding of the transmission of the major axis end sections by the first shielding portion, wherein the first shielding portion shields the transmission of the steepness sections of the major axis end sections of the line beam and the transmission of major axis side end sections of the line beam, and the second shielding portion shields the steepness sections at outside of the first shielding portion in the major axis direction of the line beam.

[0010]

~~A second invention~~An embodiment provides the laser line beam improvement apparatus according to the first invention, wherein the line beam includes a flat section and steepness sections positioned at minor axis end

sections and the major axis end sections in a beam intensity profile.

[0011]

~~A third invention~~An embodiment provides the laser line beam improvement apparatus according to the ~~second invention~~above, wherein the flat section is an area with an intensity that is 97% or more of a maximum intensity in the beam intensity profile.

[0012]

~~A fourth invention~~An embodiment provides the laser line beam improvement apparatus according to the ~~second invention~~above, wherein the first shielding portion shields the transmission of the steepness sections of the major axis end sections of the line beam and the transmission of major axis side end sections of the flat section of the line beam.

[0013]

~~A fifth invention~~An embodiment provides the laser line beam improvement apparatus according to ~~any of the first to fourth inventions~~the above, wherein the second shielding portion performs the shielding at the same position or outside of the first shielding portion in a major axis direction of the line beam.

[0014]

~~A sixth invention~~An embodiment provides the laser line beam improvement apparatus according to ~~any of the first to fifth inventions~~the above, wherein the second shielding portions include a plurality of shielding portions at different far-and-near positions relative to the object to be processed, the plurality of shielding portions further shielding the transmission of the major axis end sections of the line beam after the shielding of the transmission of the major axis end sections of the line beam by the shielding portion of a former stage.

[0015]

~~A seventh invention~~An embodiment provides the laser line beam improvement apparatus according to the ~~sixth invention~~above, wherein in the plurality of shielding portions, the shielding portion of a later stage performs the shielding at the same position or outside of the shielding portion of the former stage.

[0016]

~~An eighth invention~~According to a second aspect of the invention provides a laser processing apparatus including: a laser light source that outputs a laser; an optical system that forms a beam profile of the laser into a line beam which comprises a flat section and steepness sections positioned at minor axis end sections and the major axis end sections in a beam intensity profile to ~~and~~ guide~~s~~ the laser; a processing chamber that is provided with an object to be processed and that introduces the laser guided by the optical system through an introduction window to emit the laser to the object to be processed; and the laser line beam improvement apparatus according to ~~any of the first to~~the above ~~seventh inventions~~, wherein the first shielding portion of the line beam improvement apparatus is arranged outside of the processing chamber, between a condensing lens at a final stage of the optical system and the introduction window, and the second shielding portion of the line beam improvement apparatus is arranged in the processing chamber inside of the introduction window.

[0017]

~~A ninth invention~~An embodiment provides the laser processing apparatus according to the ~~eighth invention~~above that emits the laser to the object to be processed and that is used

in a crystallization or activation process of the object to be processed.

[0018]

According to embodiments of the present invention, the first shielding portion shields the transmission of the major axis end sections of the line beam at a stage in which the degree of condensing on the minor axis side is small, and the energy density is not high. The second shielding portion further shields the transmission of the major axis end sections of the line beam with reduced steepness sections, and the steepness sections are effectively reduced.

The first shielding portion is in a stage in which condensing on the minor axis side is gentle, and the damage to the first shielding portion can be reduced with the steepness sections reduced. The extension of the steepness sections extended after the transmission through the first shielding portion is smaller than that of the steepness sections reaching the first shielding portion. The second shielding portion can shield the transmission of the major axis side end sections of the line beam, and the extension of the steepness sections can be smaller.

The cross-sectional area of the steepness sections, which are shielded by the second shielding portion, emitted to the second shielding portion is smaller than when the steepness sections are emitted to the second

Claims

[Claim 1]

A laser line beam improvement apparatus comprising:

a first shielding portion that is arranged at a position relatively far from an object to be processed on an optical path of a line beam emitted to the object to be processed and that shields transmission of major axis end sections of the line beam; and

a second shielding portion that is arranged at positions relatively near the object to be processed and that further shields the transmission of the major axis end sections of the line beam after the shielding of the transmission of the major axis end sections by the first shielding portion.

[Claim 2]

The laser line beam improvement apparatus according to claim 1, wherein

the line beam includes a flat section and steepness sections positioned at minor axis end sections and the major axis end sections in a beam intensity profile.

[Claim 3]

The laser line beam improvement apparatus according to claim 2, wherein

the flat section is an area with an intensity that is 97% or more of a maximum intensity in the beam intensity profile.

[Claim 4]

The laser line beam improvement apparatus according to claim 2, wherein

the first shielding portion shields the transmission of the steepness sections of the major axis end sections of the line beam and the transmission of major axis side end sections of the flat section of the line beam.

[Claim 5]

The laser line beam improvement apparatus according to any of claims 1 to 4, wherein

the second shielding portion performs the shielding at the same position or outside of the first shielding portion in a major axis direction of the line beam.

[Claim 6]

The laser line beam improvement apparatus according to any of claims 1 to 5, wherein

the second shielding portion includes a plurality of shielding portions at different far-and-near positions relative to the object to be processed, the plurality of shielding portions further shielding the transmission of the major axis end sections of the line beam after the shielding of the transmission of the major axis end sections of the line beam by the shielding portion of a former stage.

[Claim 7]

The laser line beam improvement apparatus according to claim 6, wherein

in the plurality of shielding portions, the shielding portion of a later stage performs the shielding at the same position or outside of the shielding portion of the former stage.

[Claim 8]

A laser processing apparatus comprising:

a laser light source that outputs a laser;

an optical system that forms a beam profile of the laser into a line beam to guide the laser;

a processing chamber that is provided with an object to be processed and that introduces the laser guided by the optical system through an introduction window to emit the laser to the object to be processed; and

the laser line beam improvement apparatus according to any of claims 1 to 7, wherein

the first shielding portion of the line beam improvement apparatus is arranged outside of the processing chamber, between a condensing lens at a final stage of the optical system and the introduction window, and

the second shielding portion of the line beam improvement apparatus is arranged in the processing chamber inside of the introduction window.

[Claim 9]

The laser processing apparatus according to claim 8 that emits the laser to the object to be processed and

that is used in a crystallization or activation process of the object to be processed.

Claims

[Claim 1]

A laser line beam improvement apparatus comprising:

a first shielding portion that is arranged at a position relatively far from an object to be processed on an optical path of a line beam emitted to the object to be processed and that shields transmission of major axis end sections of the line beam, the line beam comprising a flat section and steepness sections positioned at minor axis end sections and the major axis end sections in a beam intensity profile; and

a second shielding portion that is arranged at positions relatively near the object to be processed and that further shields the transmission of the major axis end sections of the line beam after the shielding of the transmission of the major axis end sections by the first shielding portion, wherein

the first shielding portion shields the transmission of the steepness sections of the major axis end sections of the line beam and the transmission of major axis side end sections of the flat section of the line beam, and the second shielding portion shields the steepness sections at outside of the first shielding portion in the major axis direction of the line beam.

[Claim 2]

The laser line beam improvement apparatus according to claim 1, wherein

the flat section is an area with an intensity that is 97% or more of a maximum intensity in the beam intensity profile.

[Claim 3]

The laser line beam improvement apparatus according to claims 1 or 2, wherein

the second shielding portion includes a plurality of shielding portions at different far-and-near positions relative to the object to be processed, the plurality of shielding portions further shielding the transmission of the major axis end sections of the line beam after the shielding of the transmission of the major axis end sections of the line beam by the shielding portion of a former stage.

[Claim 4]

The laser line beam improvement apparatus according to claim 3, wherein

in the plurality of shielding portions, the shielding portion of a later stage performs the shielding at the same position or outside of the shielding portion of the former stage.

[Claim 5]

A laser processing apparatus comprising:

a laser light source that outputs a laser;

an optical system that forms a beam profile of the laser into a line beam which comprises a flat section and steepness sections positioned at minor axis end sections and the major axis end sections in a beam intensity profile to guide the laser;

a processing chamber that is provided with an object to be processed and that introduces the laser guided by the optical system through an introduction window to emit the laser to the object to be processed; and

the laser line beam improvement apparatus according to any of claims 1 to 4, wherein

the first shielding portion of the line beam improvement apparatus is arranged outside of the processing chamber, between a condensing lens at a final stage of the optical system and the introduction window, and

the second shielding portion of the line beam improvement apparatus is arranged in the processing chamber inside of the introduction window.

[Claim 6]

The laser processing apparatus according to claim 5 that emits the laser to the object to be processed and

that is used in a crystallization or activation process of the object to be processed.