The present invention is devised in view of the foregoing problem, and has an object of providing a laser annealing treatment apparatus and a treatment method which can increase the range of the energy density, namely the proper margin, suitable for the crystallization and the like while restraining a decrease in throughput as much as possible.

According to a first aspect of the present invention, a laser annealing treatment apparatus to crystallize an amorphous silicon semiconductor film by irradiating a pulsed laser light to the amorphous silicon semiconductor film with relatively scanning the pulse laser light with respect to the amorphous silicon semiconductor film is provided. The laser annealing treatment apparatus comprises a laser light source that outputs pulse laser light; an optical system that shapes the pulse laser light, and leads the shaped pulse laser light to a semiconductor film subject to treatment; and a stage to be set the semiconductor film to be irradiated by the pulse laser light, wherein the pulse laser light irradiating the semiconductor film, which the pulse laser light is obtained by superimposing or synthesizing a plurality of pulsed laser lights, presents a rising time equal to or less than 30 nanoseconds from 10% of the maximum height to the maximum height in the pulse energy density, and a falling time equal to or more than 85 nanoseconds from the maximum height to 10% of the maximum height so as to obtain crystals having a crystal grain diameter of equal to or more than 200 nanometers by irradiating the pulse laser light to the amorphous silicon semiconductor film.

According to a second aspect of the present invention, a laser annealing treatment method is provided. The method comprises obtaining pulse laser light which presents a rising time equal to or less than 30 nanoseconds from 10% of the maximum height to the maximum height in the pulse energy density, with superimposing or synthesizing a plurality of pulsed laser lights, and a falling time equal to or more than 85 nanoseconds from the maximum height to 10% of the maximum height in a pulse waveform; and a relatively scanning the pulse laser light with respect to an amorphous silicon semiconductor film while the pulse laser light is irradiating the amorphous silicon semiconductor film, thereby carrying out crystallization surface treatment of the semiconductor film to obtain crystals having a crystal grain diameter of equal to or more than 200 nanometers.

MEANS OF SOLVING THE PROBLEMS

[0006]

That is, a laser annealing treatment apparatus according to the present invention in a first aspect, includes a laser light source that outputs pulse laser light, an optical system that shapes the pulse laser light, and leads the shaped pulse laser light to a semiconductor film subject to treatment, and a stage to be set the semiconductor film to be irradiated by the pulse laser light, where the pulse laser light irradiating the semiconductor film presents a rising time equal to or less than 35 nanoseconds from 10% of the maximum height to the maximum height in the pulse energy density, and a falling time equal to or more than 80 nanoseconds from the maximum height to 10% of the maximum height.

[0007] The laser annealing treatment apparatus in a second aspect of the present invention in a first aspect is characterized in that the rising time is equal to or less than 30 nanoseconds, and the falling time is equal to or more than 85 nanoseconds.

[0008] The laser annealing treatment apparatus in a third aspect of the present invention in the first aspect or the second aspect is characterized in that the apparatus includes a waveform shaping unit that shapes the pulse laser light output from the laser light source into a pulse waveform having the rising time and the falling time.

[0009] The laser annealing treatment apparatus in a fourth aspect of the present invention in the third aspect is characterized in that the waveform shaping unit includes beam splitting means that splits the pulse laser light output from the laser light source into a plurality of beams, delay means that delays each of the split beams, and beam synthesizing means that synthesizes the respective split beams.

[0010] The laser annealing treatment apparatus in a fifth aspect of the present invention in any one of the first to fourth aspect is characterized in that the apparatus includes a plurality of laser light sources, wherein beams of the pulse laser light output