CLAIMS

What is claimed is:

1. A method for visualizing a laser energy distribution in a laser processing operation performed by a laser processing system including a laser energy source and a scanning laser processing head that provides laser movement, the method comprising:

receiving laser processing parameters associated with the laser energy source and laser movement parameters associated with the laser movement provided by the scanning laser processing head,

wherein the laser processing parameters and the laser movement parameters are used in a laser processing operation performed by the laser processing system including the laser energy source and the scanning laser processing head;

determining laser energy distributions at a plurality of locations within the laser movement based at least in part on the received laser processing parameters and the laser movement parameters;

displaying a visual representation of the laser energy distributions at the plurality of locations within the laser movement, wherein the visual representation of the laser energy distributions is used to troubleshoot the laser processing operation and/or to predict actual laser energy distributions in the laser processing operation; and

performing a laser processing operation on a workpiece using the laser processing system, wherein the laser processing operation is performed using the laser processing parameters and the laser movement parameters that were used to display the visual representation of the laser energy distribution.

2. The method of claim 1,

wherein the laser processing operation is performed before using the laser processing parameters and the laser movement parameters to display the visual representation of the laser energy distribution, and wherein the visual representation of the laser energy distributions is used to troubleshoot the laser processing operation.

3. The method of claim 1,

wherein the laser processing operation is performed after using the laser processing parameters and the laser movement parameters to display the visual representation of the laser energy distribution, and wherein the visual representation of the laser energy distributions is used to predict laser energy distributions in the laser processing operation.

4. The method of claim 1,

wherein the laser movement is within a field of view less than 30 x 30 mm.

5. The method of claim 1,

wherein the laser movement parameters are selected from the group consisting of laser movement pattern, laser movement orientation, laser movement frequency, and laser movement amplitude.

6. The method of claim 1,

wherein the laser movement parameters include at least a laser movement pattern.

7. The method of claim 6,

wherein the laser movement pattern is selected from the group consisting of a circular pattern, a figure 8 pattern, an infinity pattern, and a line pattern.

8. The method of claim 6,

wherein the laser movement pattern is user defined.

9. The method of claim 6,

wherein the laser movement parameters further include laser movement frequency and laser movement amplitude.

10. The method of claim 1,

wherein the laser processing parameters are selected from the group consisting of beam profile, beam diameter, velocity and laser power.

11. The method of claim 1,

wherein determining the laser energy distributions includes calculating a beam exposure time for each of the plurality of locations based on the laser processing parameters and the laser movement parameters and calculating an energy density for each of the plurality of locations based on the beam exposure time.

12. The method of claim 11,

wherein displaying the visual representation includes transforming the energy density for each of the plurality of locations into a color and displaying the color in the respective locations on a screen.

13. The method of claim 1,

wherein displaying the visual representation includes displaying colors associated with the laser energy distributions in the respective locations on a screen.

14. The method of claim 1,

wherein the laser energy distributions are determined for a plurality of laser movement patterns, and wherein the visual representation is displayed for each of the laser movement patterns.

15. A method for visualizing a laser energy distribution in a laser processing operation performed by a laser processing system including a laser energy source and a scanning laser processing head that provides at least one laser movement, the method comprising:

performing a laser processing operation on a workpiece using the laser processing system, wherein the laser processing operation is performed using laser processing parameters associated with the laser energy source and laser movement parameters associated with the at least one laser movement provided by the scanning laser processing head;

inputting the laser processing parameters and the laser movement parameters into a visualization system;

determining laser energy distributions at a plurality of locations within the at least one laser movement based at least in part on the laser processing parameters and the laser movement parameters input into the visualization system; and

displaying a visual representation of the laser energy distributions at the plurality of locations within the laser movement, wherein the visual representation of the laser energy distributions are used to troubleshoot the laser processing operation.

16. A method for visualizing a laser energy distribution in a laser processing operation performed by a laser processing system including a laser energy source and a scanning laser processing head that provides at least one laser movement, the method comprising:

inputting, into a visualization system, laser processing parameters associated with the laser energy source and laser movement parameters associated with the at least one laser movement provided by the scanning laser processing head;

determining laser energy distributions at a plurality of locations within the at least one laser movement based at least in part on the laser processing parameters and the laser movement parameters input into the visualization system;

displaying a visual representation of the laser energy distributions at the plurality of locations within the laser movement; and

performing a laser processing operation on a workpiece using the laser processing system, wherein the laser processing operation is performed using the laser processing parameters and the laser movement parameters that produced the visual representation of the laser energy distributions.

17. A laser welding system comprising:

a fiber laser including an output fiber;

a welding head coupled to the output fiber of the fiber laser, the welding head comprising:

a collimator configured to be coupled to the output fiber of the fiber laser;

at least one movable mirror configured to receive a collimated laser beam from the collimator and to move the beam in at least one axis; and

a focus lens configured to focus the laser beam;

a control system for controlling at least the fiber laser and positions of the at least one mirror; and

a laser energy distribution visualization system programmed to receive laser processing parameters associated with the fiber laser and laser movement parameters associated with at least one laser movement by the at least one mirror in the welding head, to determine laser

energy distributions at a plurality of locations within the laser movement based at least in part on the received laser processing parameters and the laser movement parameters, and to display a visual representation of the laser energy distributions at the plurality of locations within the laser movement, wherein

the control system is configured to control the fiber laser and positions of the at least one movable mirror to perform a laser processing operation on a workpiece using the laser processing parameters and the laser movement parameters that were used to display the visual representation of the laser energy distribution.

18. The laser welding system of claim 17,

wherein the fiber laser includes an Ytterbium fiber laser.

19. The laser welding system of claim 17,

wherein the control system is configured to control the at least one mirror to provide a wobble pattern.

20. The laser welding system of claim 17,

wherein the control system is configured to control the fiber laser to adjust laser power in response to movement and/or a position of the beam.

21. The laser welding system of claim 17,

wherein the at least one movable mirror is configured to move the beam within only a limited field of view defined by a scan angle of about 1-2º.