CLAIMS

1. A beam steering system for materials processing, the system comprising:

a multi-channel beam splitter arranged and configured to split an input first optical signal into a plurality of split first optical signals;

a plurality of phase modulators, wherein each phase modulator of the plurality of phase modulators is operative to modify a phase of a corresponding split first optical signal of the plurality of split first optical signals in response to a control signal;

a waveguide arranged at an optical output of the plurality of phase modulators, the waveguide configured to spatially-rearrange the split first optical signals output from the plurality of phase modulators into a pattern; ~~and~~

an optical amplifier arranged at an optical output of the waveguide, the optical amplifier configured to amplify the spatially-rearranged split first optical signals output by the waveguide, thereby producing a combined first optical signal;

a harmonic conversion module arranged to receive the combined first optical signal, the harmonic conversion module configured to modify a wavelength of the combined first optical signal; and

a lens arranged between the optical amplifier and the harmonic conversion module, wherein the lens is configured to collimate light of the combined first optical signal received at the harmonic conversion module.

2. The system of claim 1, further comprising:

a beam splitter arranged at an optical output of the optical amplifier, the beam splitter configured to transmit a first portion of the combined first optical signal output by the optical amplifier and reflect a second portion of the combined first optical signal output by the optical amplifier; and

a first photodetector arranged to receive the second portion of the combined first optical signal and output a corresponding first detection signal.

3. The system of claim 2, further comprising control circuitry communicatively coupled to an output of the first photodetector and to an input of each of the plurality of phase modulators, wherein the control circuitry is configured to generate and output the control signal.

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4. The system of claim 1, wherein the plurality of phase modulators and the waveguide are located within a common photonic integrated circuit.

5. The system of claim 1, further comprising a seed laser arranged and configured to generate the first optical signal.

6. The system of claim 1, wherein the first optical signal has a first wavelength in a range from 1000 nm to 1150 nm.

7. The system of claim 3, further comprising an amplitude modulator operative to modulate an amplitude of the input first optical signal in response to a control signal, wherein the multi-channel beam splitter is arranged at an optical output of the amplitude modulator.

8. The system of claim 7, wherein the amplitude modulator and the multi-channel beam splitter are located within a common photonic integrated circuit.

9. The system of claim 7, wherein the control circuitry is configured to output a control signal to each of the plurality of phase modulators to effect, in combination with the configuration of the pattern of the waveguide, phased-array beam steering at the optical output of the waveguide.

10. The system of claim 9, wherein the control circuitry is configured to output a control signal to the amplitude modulator based on the magnitude of the phased-array beam steering effected, at least partially, by plurality of phase modulators.

11. The system of claim 3, wherein the control circuitry is configured to output a control signal to the plurality of phase modulators based, at least in part on the first detection signal, to stabilize the phases of the split first optical signals output from the optical amplifier.

12. The system of claim 3, further comprising a reference laser configured to generate a second optical signal.

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13. The system of claim 12, wherein the second optical signal has a second wavelength that is different from a wavelength of the first optical signal.

14. The system of claim 13, wherein the second wavelength is in a range from 1070 nm to 1150 nm.

15. The system of claim 12, wherein the multi-channel beam splitter is arranged and configured to split the second optical signal into a plurality of split second optical signals.

16. The system of claim 15, wherein each phase modulator of the plurality of phase modulators is operative to modify a phase of a corresponding split second optical signal of the plurality of split second optical signals in response to the control signal.

17. The system of claim 16, wherein the waveguide is configured to spatially-rearrange the split second optical signals output from the plurality of phase modulators into the pattern such that the split second optical signals are coherently combinable into a combined second optical signal.

18. The system of claim 17, further comprising a dichroic mirror arranged between beam splitter and the optical output of the optical amplifier, the dichroic mirror configured to reflect the combined second optical signal and transmit the combined first optical signal.

19. The system of claim 18, further comprising a second photodetector arranged to receive the combined second optical signal reflected by the dichroic mirror and output a corresponding second detection signal.

20. The system of claim 19, wherein the control circuitry is configured to output the control signal to the plurality of phase modulators based, at least in part on the second detection signal, to stabilize the phases of the split second optical signals output from the plurality of phase modulators.

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21. The system of claim 2, wherein the ~~further comprising a~~ harmonic conversion module is arranged to receive the first portion of the combined first optical signal~~, the harmonic conversion module configured to modify a wavelength of the first portion of the combined first optical signal~~.

22. The system of claim 2, further comprising a beam positioning system arranged to receive the first portion of the combined first optical signal and configured to deflect the first portion of the combined first optical signal.

~~23. A system, comprising:~~

~~a first beam positioning system operative to deflect a laser beam having a first wavelength;~~

~~a second beam positioning system disposed within a beam path along which the laser beam is propagatable after deflection by the first beam positioning system; and~~

~~a harmonic conversion module disposed within the beam path between the first beam positioning system and the second beam positioning system,~~

~~wherein the harmonic conversion module is operative to convert the first wavelength of the laser beam to a second wavelength.~~

~~24. The system of claim 23, wherein the beam positioning system includes a phased-array beam positioning system.~~

~~25. The system of claim 23, wherein the beam positioning system includes an acousto-optic deflector.~~

~~26. The system of claim 25, wherein the acousto-optic deflector is a shear-wave TeO_2 acousto-optic deflector.~~

~~27. The system of claim 25, wherein the acousto-optic deflector is a quartz acousto-optic deflector.~~

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~~28. The system of claim 23, wherein the first wavelength is in the infra-red range of the electromagnetic spectrum.~~

~~29. The system of claim 23, wherein the second wavelength is in the visible range of the electromagnetic spectrum.~~

~~30. The system of claim 23, wherein the second wavelength is in the ultra-violet range of the electromagnetic spectrum.~~

~~31~~23. The system of claim 1, wherein each of the plurality of phase modulators is additionally operative to modify an amplitude of a corresponding split first optical signal of the plurality of split first optical signals in response to a control signal.

~~32~~24. The system of claim 21, ~~further comprising a~~ wherein the lens is arranged between the optical amplifier and the harmonic conversion module~~, wherein the lens is configured to collimate light in the first portion of the first optical signal received at the harmonic conversion module~~ beam splitter.