CLAIMS

1. A laser device comprising:

a gain medium comprising a facet; and

a metasurface comprising a plurality of supercells, the metasurface disposed on a substrate and configured to:

reflect and focus a first portion of light from the facet back to the gain medium as a feedback beam; and

reflect a second portion of the light as an output beam at an angle that is nonzero relative to a direction of the feedback beam;

wherein the metasurface is configured to focus the feedback beam at a first point for a first operating wavelength, a second point for a second operating wavelength, and a third point for a third operating wavelength; and

wherein the first point, the second point, and the third point are located on a straight line.

2. The laser device of claim 1, wherein spatially translating the metasurface with respect to the gain medium modifies a wavelength of the feedback beam.

3. The laser device of claim 1, wherein:

the metasurface is configured to reflect the output beam at an angle orthogonal to a plane of the substrate; and

the output beam is a collimated beam.

4. The laser device of claim 1, wherein the plurality of supercells is arranged in a curvilinear lattice.

5. The laser device of claim 1, wherein:

each supercell of the plurality of supercells comprise one or more elements; and

an angle and intensity of the feedback beam and an angle and intensity of the output beam are defined according to at least one of a position of the one or more elements, a dimension of the one or more elements, a geometry of the one or more elements, or an orientation of the one or more elements.

6. The laser device of claim 1, wherein:

each supercell of the plurality of supercells comprise one or more elements; and

a polarization and shape of the output beam is defined according to at least one of a position of the one or more elements, a dimension of the one or more elements, a geometry of the one or more elements, or an orientation of the one or more elements.

7. The laser device of claim 1, further comprising:

a thermoelectric cooling element; and

a mirror disposed on at least one of the thermoelectric cooling element or a substrate of the gain medium, the mirror configured to receive the output beam from the metasurface and to reflect the output beam away from the at least one of the thermoelectric cooling element or the substrate of the gain medium.

8. A laser device comprising:

a gain medium comprising a facet; and

a metasurface comprising a plurality of supercells, the metasurface disposed on a substrate and configured to:

reflect and focus a first portion of light from the facet back to the gain medium as a feedback beam; and

reflect a second portion of the light as an output beam at an angle that is nonzero relative to a direction of the feedback beam;

and

a spatial light modulator disposed between the gain medium and the metasurface, the spatial light modulator configured to tune a wavelength of the output beam.

9. The laser device of claim 1, wherein the gain medium is a laser diode and the facet is a first facet comprising an anti-reflective coating, the laser device further comprising a second facet comprising a reflective coating.

10. The laser device of claim 1, wherein:

each supercell of the plurality of supercells comprises one or more elements; and

a phase and shape of the output beam are defined according to at least one of a position of the one or more elements, a dimension of the one or more elements, a geometry of the one or more elements, or an orientation of the one or more elements.

11. The laser device of claim 1, wherein the gain medium is at least one of a solid-state laser medium, a semiconductor laser medium, a crystal laser medium, a doped glass laser medium, a gas laser medium, a dye, or a quantum confinement effect laser medium.

12. The laser device of claim 1, further comprising:

a translation stage configured to spatially translate the metasurface with respect to the gain medium.

13. A laser device comprising:

a gain medium comprising a facet; and

a metasurface comprising a plurality of supercells, the metasurface disposed on a substrate and configured to:

reflect and focus a first portion of light from the facet to the gain medium as a feedback beam; and

transmit a second portion of the light as an output beam through the metasurface away from the facet;

wherein the metasurface is configured to focus the feedback beam at a first point for a first operating wavelength, a second point for a second operating wavelength, and a third point for a third operating wavelength; and

wherein the first point, the second point, and the third point are located on a straight line.

14. The laser device of claim 13, comprising:

a lens, configured to collimate the output beam from the metasurface; or

the metasurface, configured to provide the output beam as a collimated beam.

15. The laser device of claim 13, wherein spatially translating the metasurface with respect to the gain medium modifies a wavelength of the feedback beam and a wavelength of the output beam without changing a direction of the output beam.

16. The laser device of claim 13, wherein the plurality of supercells is arranged in a curvilinear lattice.

17. The laser device of claim 13, wherein:

each supercell of the plurality of supercells comprise one or more elements; and

an angle and intensity of the feedback beam and an angle and intensity of the output beam is defined according to at least a position of the one or more elements, a dimension of the one or more elements, a geometry of the one or more elements, or an orientation of the one or more elements.

18. The laser device of claim 13, wherein:

each supercell of the plurality of supercells comprises one or more elements; and

a polarization of the output beam is defined according to at least a position of the one or more elements, a dimension of the one or more elements, a geometry of the one or more elements, or an orientation of the one or more elements.