CLAIMS

1. A laser oscillator for generating laser energy having a pulse duration of less than 1 nanosecond comprising:

(a) a first mirror and a second mirror within a housing, with the first mirror and the second mirror providing a sub-nanosecond round trip time for laser radiation along an axis between the first mirror and the second mirror;

(b) an electro-optic device, a polarizer and a lasing medium positioned between the first mirror and the second mirror along the axis; and

(c) a pump source operatively coupled to the lasing medium,

(d) wherein the laser oscillator is capable of proceeding through at least three consecutive states comprising hold-off, buildup and cavity dumping, and

wherein the pump source operatively coupled to the lasing medium provides pumping radiation along an end of the lasing medium via an optical element.

2. The laser oscillator of claim 1, wherein the cavity dumping state has a range of acceptable transient times that are greater than the ideal step function transient time.

3. The laser oscillator of claim 1, wherein the cavity dumping state has a range of acceptable transient times that are greater than the ideal step function transient time, wherein a range of acceptable transient times includes from 0.5 round trip times to 5 round trip times which generates output pulse durations that range from 1 round trip time to 2.5 round trip times, the round trip time being sub-nanosecond.

4. The laser oscillator of claim 1, wherein the first mirror and the second mirror are fixed within the housing to define a static resonator chamber having a sub-nanosecond round trip time.

5. The laser oscillator of claim 1, wherein the lasing medium comprises Alexandrite, Ti:S, Nd:YAG, Nd:YAP, Nd:$YAlO_3$, Nd:YLF, yttrium-aluminum garnet doped with a rare earth or a transition metal ion dopant, yttrium-aluminum perovskite doped with a rare earth or a transition metal ion dopant, yttrium aluminum oxide doped with a rare earth or a transition metal ion dopant, a vanadate crystal, YVO_4, fluoride glasses, ZBLN, silica glasses, minerals, ruby, crystals or glass media hosts.

6. The laser oscillator of claim 1, wherein the sub-nanosecond round trip time is between 500 and 900 ps.

7. The laser oscillator of claim 1, wherein the pump source operatively coupled to the lasing medium provides pumping radiation along a longitudinal side of the lasing medium.

8. The laser oscillator of claim 1, wherein the pump source operatively coupled to the lasing medium provides pumping radiation along a longitudinal side of the lasing medium via an optical element.

9. The laser oscillator of claim 1, wherein the pump source operatively coupled to the lasing medium includes two pump sources providing pumping radiation along opposite longitudinal sides of the lasing medium via an optical element.

10. The laser oscillator of claim 1 wherein the pump source includes at least one flash lamp having an axis transverse to the optical axis of the lasing medium.

11. The laser oscillator of claim 1 wherein the pump source includes a pair of flash lamps, each flash lamp having an axis transverse to the optical axis of the lasing medium.

12. The laser oscillator of claim 1, wherein the pump source includes a manifold and a pair of flash lamps, each flash lamp extends through a flash lamp channel in the manifold, the lasing medium extends through a lasing channel in the manifold, and the lasing medium and lasing channel extend transversely with respect to the flash lamps and flash lamp channel.

13. The laser oscillator of claim 1, wherein the pump source includes a ceramic diffuse reflector and a pair of flash lamps, the flash lamps extend through a flash lamp channel in the ceramic diffuse reflector, the lasing medium extends through a lasing channel in the ceramic diffuse reflector, and the lasing medium and lasing channel extend transversely with respect to the flash lamps and flash lamp channel.

14. The laser oscillator of claim 1, wherein the pump source includes a pair of flash lamps, each flash lamp extends through a flash lamp flow tube, the lasing medium extends through

a lasing flow tube, and the lasing medium and lasing flow tube extend transversely with respect to the flash lamps and flash lamp flow tubes.

15. The laser oscillator of claim 14, wherein the lasing flow tube has an hourglass shape and includes peripheral channels at opposed ends thereof.

16. A method of generating sub-nanosecond pulsed laser energy comprising:

(a) providing a resonator having a first mirror at one end, a second mirror at the opposite end, a lasing medium, a polarizer, and an electro-optic device disposed therebetween, and wherein the resonator has a cavity round trip time of less than 1 nanosecond, and wherein the lasing medium is pumped by a pump source operatively connected to the lasing medium;

(b) applying a first voltage to the electro-optic device to hold off laser oscillation in the resonator while pumping energy into the lasing medium;

(c) applying a second voltage to the electro-optic device to build up laser energy within the resonator; and

(d) applying a third voltage to the electro-optic device to cavity dump a portion of the laser energy from the resonator, and

wherein the pump source operatively connected to the lasing medium provides pumping radiation along an end of the lasing medium via an optical element.

17. The method of claim 16 wherein the third voltage applied to the electro-optic device is a quarter wave voltage $V_{\lambda/4}$.

18. The method of claim 16 wherein the transient time between the second applied voltage and the third applied voltage is greater than the ideal step function transient time.

19. The method of claim 16 wherein the transient time between the second applied voltage and the third applied voltage is greater than the ideal step function transient time and wherein a range of acceptable transient times includes from 0.5 round trip times to 5 round trip times which generates output pulse durations that range from 1 round trip time to 2.5 round trip times, the round trip time being sub-nanosecond.

20. The method of claim 16 wherein the pulsed laser energy has a pulse duration of between 100 ps and 900 ps.

21. The method of claim 16, wherein said pulsed laser energy has at least 100 mJ/pulse.

22. The method of claim 16, wherein the first mirror and the second mirror are fixed within the housing to define a static resonator chamber having a sub-nanosecond round trip time.

23. The method of claim 16, wherein the lasing medium comprises Alexandrite, Ti:S, Nd:YAG, Nd:YAP, Nd:$YAlO_3$, Nd:YLF, yttrium-aluminum garnet doped with a rare earth or a transition metal ion dopant, yttrium-aluminum perovskite doped with a rare earth or a transition metal ion dopant, yttrium aluminum oxide doped with a rare earth or a transition metal ion dopant, a vanadate crystal, YVO_4, fluoride glasses, ZBLN, silica glasses, minerals, ruby, crystals or glass media hosts.

24. The method of claim 16, wherein the sub-nanosecond round trip time is between 500 and 900 ps.

25. The method of claim 16, wherein the pump source operatively connected to the lasing medium provides pumping radiation along a longitudinal side of the lasing medium.

26. The method of claim 16, wherein the pump source operatively connected to the lasing medium provides pumping radiation along a longitudinal side of the lasing medium via an optical element.

27. The method of claim 16, wherein the pump source operatively connected to the lasing medium includes two pump sources providing pumping radiation along opposite longitudinal sides of the lasing medium via an optical element.

28. The method of claim 16 wherein the pump source includes at least one flash lamp having an axis transverse to the optical axis of the lasing medium.

29. The method of claim 16 wherein the pump source includes a pair of flash lamps, each flash lamp having an axis transverse to the optical axis of the lasing medium.

30. The method of claim 16, wherein the pump source includes a manifold and a pair of flash lamps, each flash lamp extends through a flash lamp channel in the manifold, the lasing

medium extends through a lasing channel in the manifold, and the lasing medium and lasing channel extend transversely with respect to the flash lamps and flash lamp channel.

31. The method of claim 16, wherein the pump source includes a ceramic diffuse reflector and a pair of flash lamps, the flash lamps extend through a flash lamp channel in the ceramic diffuse reflector, the lasing medium extends through a lasing channel in the ceramic diffuse reflector, and the lasing medium and lasing channel extend transversely with respect to the flash lamps and flash lamp channel.

32. The method of claim 16, wherein the pump source includes a pair of flash lamps, each flash lamp extends through a flash lamp flow tube, the lasing medium extends through a lasing flow tube, and the lasing medium and lasing flow tube extend transversely with respect to the flash lamps and flash lamp flow tubes.

33. The method of claim 32, wherein the lasing flow tube has an hourglass shape and includes peripheral channels at opposed ends thereof.

34. A method of generating sub-nanosecond pulsed laser energy and cosmetically treating pigmented skin comprising:

(a) providing a resonator having a first mirror at one end, a second mirror at the opposite end, a lasing medium, a polarizer, and an electro-optic device are disposed there between, and wherein the resonator has a cavity round trip time of less than 1 nanosecond, and wherein the lasing medium is pumped by a pump source operatively connected to the lasing medium;

(b) applying a first voltage to the electro-optic device to hold off laser oscillation in the resonator while pumping energy into the lasing medium;

(c) applying a second voltage to the electro-optic device to build up laser energy within the resonator;

(d) applying a third voltage to the electro-optic device to cavity dump a portion of the laser energy from the resonator; and

(e) exposing pigmented skin of a patient to the laser energy with pulses having a duration of at most 990 ps and an energy of at least 10 mJ/pulse, and

wherein the pump source operatively connected to the lasing medium provides pumping radiation along an end of the lasing medium via an optical element.

35. A method for cosmetically treating a skin pigmentation comprising generating pulsed laser energy by:

(a) reflecting laser energy generated by a lasing medium between a first mirror at one end of a resonator and a second mirror at the opposite end of said resonator and through a polarizer and an electro-optical device within the resonator and wherein the resonator has a cavity round trip time of less than 1 nanosecond, and wherein the lasing medium is pumped by a pump source operatively connected to the lasing medium;

(b) amplifying laser energy within the resonator by applying to the electro-optical device a first constant voltage;

(c) Q-switching the resonator;

(d) then cavity dumping the amplified laser energy from the resonator by applying to the electro-optical device a quarter wave voltage $V_{\lambda/4}$; and

(e) exposing pigmented skin of a patient to the pulsed laser energy with pulses having a duration of at most 990 ps and an energy of at least 10 mJ/pulse, and

wherein the pump source operatively connected to the lasing medium provides pumping radiation along an end of the lasing medium via an optical element.