CLAIMS

1. A photoacoustic compression method for machining a transparent target material, comprising the steps of:

applying a laser beam having at least one burst of laser pulses, said laser beam operating at a wavelength less than 5 μm, a laser burst pulse repetition rate between 1 Hz to 2 MHz having a number of subpulses in the range of 1 to 50 per burst of said laser pulses, and, each pulse having burst pulse energy of 5-500 μJ, from a laser beam source to a distributive focus lens focusing assembly which focuses said laser pulses, prior to application of said laser pulses to said surface of said transparent target;

total pulse energy or fluence applied to said transparent target at a spot where said laser pulses contact a surface of said transparent target, said spot being the point of initiation of machining on said transparent target determined by said wavelength, said laser burst pulse repetition rate, said number of subpulses per burst, and said burst pulse energy; and,

adjusting said wavelength, adjusting said laser burst pulse repetition rate, adjusting said number of subpulses per burst, and adjusting said energy per pulse to initiate and propagate photoacoustic compression machining, and prevent ablative machining.

2. The photoacoustic compression method for machining a transparent target material, as claimed in claim 1, wherein said focusing comprises:

delivering said laser pulses to said surface of said transparent target after adjustment of the relative distance or angle of said distributive focus lens focusing assembly in relation to said laser source;

focusing said laser pulses in said distributive focus lens focusing assembly so as to create a principal focal waist and at least one secondary focal waist; and,

adjusting said principal focal waist such that said principal focal waist does not reside on or in said transparent target that is being machined.

3. The photoacoustic compression method for machining a transparent target material, as claimed in claim 1, wherein said focusing comprises:

delivering said laser pulses to said surface of said transparent target after adjustment of the relative distance or angle of said distributive focus lens focusing assembly in relation to said laser source; and,

focusing said laser pulses in said distributive focus lens focusing assembly so as to create a principal focal waist and at least one secondary focal waist; and,

adjusting said transparent target distance with respect to said principal focal waist and at least one secondary focal waist.

4. The photoacoustic compression method for machining a transparent target material, as claimed in claim 2, further comprising the steps of:

adjusting said focus of said laser pulses such that said spot is located below or above said principal focal waist, said spot has a diameter larger than a diameter of a filament formed in said transparent target.

5. The photoacoustic compression method for machining a transparent target material, as claimed in claim 3, further comprising the steps of:

adjusting said focus of said laser pulses such that said spot is located below or above said principal focal waist, said spot has a diameter larger than a diameter of a filament formed in said transparent target.

6. The photoacoustic compression method for machining a transparent target material, as claimed in claim 2, wherein said transparent target may be comprised of one or a set of transparent wafers, plates or substrates in a layered configuration; and wherein machining of said transparent target is the drilling of stopped or through orifices beginning at any depth and in any one of said set of wafers, plates or substrates in said layered configuration.

7. The photoacoustic compression method for machining a transparent target material, as claimed in claim 3, wherein said transparent target may be comprised of one or a set of transparent wafers, plates or substrates in a layered configuration; and wherein machining of said transparent target is the drilling of stopped or through orifices beginning at any depth and in any one of said set of wafers, plates or substrates in said layered configuration.

8. The photoacoustic compression method for machining a transparent target material, as claimed in claim 1, wherein said transparent target may be comprised of one or a set of transparent wafers, plates or substrates in a layered configuration; and wherein machining of said transparent target is the drilling of stopped or through orifices beginning at any depth and in any one of said set of wafers, plates or substrates in said layered configuration.

9. The photoacoustic compression method for machining a transparent target material, as claimed in claim 2, wherein said distributive focus lens focusing assembly determines said fluence level of said secondary focal waists, said secondary focal waists are of sufficient intensity and number to ensure propagation of said photoacoustic compressive machining through a desired volume of said transparent target.

10. The photoacoustic compression method for machining a transparent target material, as claimed in claim 3, wherein said distributive focus lens focusing assembly determines said fluence level of said secondary focal waists, said secondary focal waists are of sufficient intensity and number to ensure propagation of said photoacoustic compressive machining through a desired volume of said transparent target.

11. The photoacoustic compression method for machining a transparent target material, as claimed in claim 1, wherein said laser pulses have a burst frequency in the range of 100 kHz to 90 MHz to maintain photoacoustic compression within said transparent target, said laser pulses having a pulse width of less than 10 nanoseconds.

12. The photoacoustic compression method for machining a transparent target material, as claimed in claim 1, including applying a sacrificial layer to a surface of said material prior to the said application of said burst of laser pulses.

13. The photoacoustic compression method for machining a transparent target material, as claimed in claim 1, wherein no material from said transparent target material is removed from said transparent target by said photoacoustic compression.

14. The photoacoustic compression method for machining a transparent target material, as claimed in claim 1, wherein said distributive focus lens focusing assembly is selected from the group consisting of: aspheric plates, telecentric lenses, non-telecentric lenses, aspheric lenses, axicon, annularly faceted lenses, custom ground aberrated non-perfect lenses, a combination of positive and negative lenses or a series of corrective plates, and, an optical element tilted with respect to the incident beam.

15. A photoacoustic compression method for machining a transparent target material, comprising the steps of:

applying a laser having at least one burst of laser pulses, said laser operating at a wavelength less than 5 μm, a laser burst pulse repetition rate between 1 Hz to 2 MHz having a number of subpulses in the range of 1 to 50 per burst of said laser pulses, said laser subpulses have a burst frequency in the range of 100 kHz to 90 MHz, said laser pulses having a pulse width of less than 10 nanoseconds, and, having burst pulse energy of 5-500 μJ, from a laser source through a distributive lens focusing assembly and to said transparent target; delivering said laser pulses to said transparent target after adjustment of the relative distance or angle of said distributive focus lens focusing assembly in relation to said laser source so as to focus said laser pulses in a distributed focus configuration creating a principal focal waist and at least one secondary focal waist;

photoacoustic compression machining is produced by said laser pulse energy delivered to said transparent target which initiates a Kerr Effect self focusing which is propagated in said transparent target by additional energy input to said transparent target by said secondary focal waists thus producing a filament within said transparent target; and, total energy input to said transparent target is below the level required to initiate ablative or vaporization based machining of said transparent target.

16. The photoacoustic compression method for machining a transparent target material, as claimed in claim 15, wherein no material from said transparent target material is removed from said transparent target by said photoacoustic compression.

17. The photoacoustic compression method for machining a transparent target material, as claimed in claim 15, wherein said distributive focus lens focusing assembly is selected from the group consisting of: aspheric plates, telecentric lenses, non-telecentric lenses, aspheric lenses, axicon, annularly faceted lenses, custom ground aberrated non-perfect lenses, a combination of positive and negative lenses or a series of corrective plates, and, an optical element tilted with respect to the incident beam.

18. A photoacoustic compression method for machining a transparent target material, comprising the steps of:

applying a laser having at least one burst of laser pulses, said burst of laser pulse having a number of subpulses in the range of 1 to 50 per burst of said laser pulses, from a laser source through a distributive lens focusing assembly and to said transparent target; adjusting said distributive focusing assembly position in relation to said laser source and said transparent target;

creating a principal focal waist and at least one secondary focal waist;

photoacoustic compression machining is produced by said laser pulse energy delivered to said transparent target which initiates a Kerr Effect self focusing which is propagated in said transparent target by additional energy input to said transparent target by said secondary focal waists thus producing a filament within said transparent target.

19. The photoacoustic compression method for machining a transparent target material, as claimed in claim 18, wherein no material from said transparent target material is removed from said transparent target by said photoacoustic compression.

20. The photoacoustic compression method for machining a transparent target material, as claimed in claim 18, wherein said distributive focus lens focusing assembly is selected from the group consisting of: aspheric plates, telecentric lenses, non-telecentric lenses, aspheric lenses, axicon, annularly faceted lenses, custom ground aberrated non-perfect lenses, a combination of positive and negative lenses or a series of corrective plates, and, an optical element tilted with respect to the incident beam.

21. The photoacoustic compression method for machining a transparent target material, as claimed in claim 18, further comprising the steps of: creating a plurality of secondary focal waists within said transparent target.

22. The photoacoustic compression method for machining a transparent target material, as claimed in claim 2, further comprising the steps of:

creating a plurality of secondary focal waists within said transparent target.

23. The photoacoustic compression method for machining a transparent target material, as claimed in claim 1, further comprising the steps of:

creating a principal focal waist above or below said transparent target; and,

creating a plurality of secondary focal waists within said transparent target.

24. The photoacoustic compression method for machining a transparent target material, as claimed in claim 1, wherein said transparent target material is selected from the group consisting of glass, oxide glasses, borosilicate glass, chemically or heat strengthened glass, glass ceramics, Sapphire, glass layered on Sapphire, glass coated with metals, glass coated with polymers, SiC, GaN, and Si wafers.