CLAIMS:

1. A method to produce an alkyne, comprising:

introducing a fuel and an oxidizer into a fuel injection zone;

combusting the fuel and the oxidizer in a combustion zone to create a carrier gas stream;

accelerating the carrier gas stream to supersonic speed in an expansion zone;

injecting a feedstock material into a feedstock injection zone using at least a first plurality of injection nozzles and a second plurality of injection nozzles, the first plurality of injection nozzles being arranged annularly on a first transverse plane of the feedstock injection zone and the second plurality of injection nozzles being arranged annularly on a second transverse plane of the feedstock injection zone;

transitioning the carrier gas stream from supersonic speed to subsonic speed to create a shockwave in a reaction zone, the reaction zone being directly connected to the feedstock injection zone and the shockwave being created adjacent to the feedstock injection zone; and

simultaneously mixing and reacting the carrier gas stream and the feedstock material, the shockwave helping to mix the carrier gas stream and the feedstock material.

2. The method of claim 1, wherein the first plurality of injection nozzles comprises at least three injection nozzles and the second plurality of injection nozzles comprises at least three injection nozzles.

3. The method of claim 1 or 2, wherein the first and second plurality of injection nozzles comprise the same number of injection nozzles and wherein the first and second plurality of injection nozzles are arranged at the same annular positions.

4. The method of claim 1 or 2, wherein the feedstock injection zone has a pipe diameter, and the first transverse plane is spaced from the second transverse plane by a distance of between 0.5 to 6 injection zone pipe diameters.

5. The method of claim 1 or 2, wherein the feedstock injection zone comprises a third plurality of injection nozzles arranged annularly on a third transverse plane of the feedstock injection zone.

6. The method of claim 1 or 2, wherein 10 wt% to 50 wt% of the feedstock material is introduced into the first plurality of injection nozzles and 50 wt% to 90 wt% of the feedstock material is introduced into the second plurality of injection nozzles.

7. The method of claim 1 or 2, further comprising introducing a diluent into the feedstock injection zone.

8. The method of claim 1 or 2, further comprising reducing a velocity of the carrier gas stream in the reaction zone to convert kinetic energy to thermal energy.

9. The method of claim 1 or 2, wherein the first plurality of injection nozzles has an angle relative to the first transverse plane in a range of 0° to less than 90°and the second plurality of injection nozzles has an angle relative to the second transverse plane in a range of 0° to 90°.

10. The method of claim 1 or 2, wherein each injection nozzle of the first and second plurality of injection nozzles is selected from the group consisting of jets, angled jets, aeroramp jets, ramp jets, strut jets, cascade jets, diamond jets, slotted holes, and annular slots, or combinations thereof.