Claims

1. A microwave plasma reactor for manufacturing synthetic diamond material via chemical vapour deposition, the microwave plasma reactor comprising:

a plasma chamber defining a resonant cavity for supporting a primary microwave resonance mode having a primary microwave resonance mode frequency f;

a plurality of microwave sources coupled to the plasma chamber for generating and feeding microwaves having a total microwave power P_T into the plasma chamber;

a gas flow system for feeding process gases into the plasma chamber and removing them therefrom; and

a substrate holder disposed in the plasma chamber and comprising a supporting surface for supporting a substrate on which the synthetic diamond material is to be deposited in use,

wherein the plurality of microwave sources are configured to couple at least 30% of the total microwave power P_T into the plasma chamber in the primary microwave resonance mode frequency f, and wherein at least some of the plurality of microwave sources are solid state microwave sources.

2. A microwave plasma reactor according to claim 1, wherein the plurality of microwave sources are configured to couple at least 40% of the total microwave power P_T into the plasma chamber in the primary microwave resonance mode frequency f.

3. A microwave plasma reactor according to claim 1 or 2, wherein the primary microwave resonance mode frequency f has a band width of no more than 10% of a mean frequency value.

4. A microwave plasma reactor according to any preceding claim, wherein the primary microwave resonance mode frequency f is lower than 896 MHz by at least 10%.

5. A microwave plasma reactor according to any preceding claim, wherein the solid state microwave sources are configured to couple less than 50% but at least 1% of the total microwave power P_T into the plasma chamber in one or more different frequencies to that of the primary microwave resonance mode.

6. A microwave plasma reactor according to any preceding claim, wherein at least several of the plurality of solid state microwave sources are each configured to generate no more than 10% of the total microwave power P_T.

7. A microwave plasma reactor according to any preceding claim, wherein at least 30% of the total microwave power P_T is provided by the solid state microwave sources.

8. A microwave plasma reactor according to any one of claims 1 to 6, wherein at least 50% of the total microwave power P_T coupled into the plasma chamber in the primary microwave resonance mode frequency f is provided by a magnetron microwave source.

9. A microwave plasma reactor according to any preceding claim, where at least 5 individual solid state microwave sources are coupled to the plasma chamber.

10. A microwave plasma reactor according to any preceding claim, where the solid state microwave sources are independently controllable.

11. A microwave plasma reactor according to any preceding claim, wherein the solid state microwave sources are configured to pulse the microwave power coupled into the plasma chamber.

12. A microwave plasma reactor according to claim 11, wherein the solid state microwave sources are configured to pulse the microwave power coupled into the plasma chamber at a pulse frequency in a range 10 Hz to 1 MHz.

13. A microwave plasma reactor according to any preceding claim, wherein one or more of the solid state microwave sources are directly coupled to the plasma chamber.

14. A microwave plasma reactor according to claim 13, wherein said solid state microwave sources are magnetically coupled to the plasma chamber.

15. A microwave plasma reactor according to claim 14, wherein said solid state microwave sources are coupled into the plasma chamber using a coaxial feed through ending in a loop antenna.

16. A microwave plasma reactor according to any preceding claim, wherein one or more of the solid state microwave sources are configured to be indirectly coupled to the plasma chamber via a separate chamber wherein one or more of the solid state microwave sources are pre-combined in the separate chamber which is coupled to the plasma chamber.

17. A microwave plasma reactor according to any preceding claim, wherein the resonance cavity of the plasma chamber is configured to support a TM_{011} resonant mode at the primary microwave resonance mode frequency f.

18. A microwave plasma reactor according to any preceding claim, wherein one or more of the solid state microwave sources are configured to be coupled to the plasma chamber through the substrate holder.

19. A microwave plasma reactor according to claim 18, wherein a plurality of substrate holders are provided for supporting a plurality of substrates on which synthetic diamond material is to be deposited and the solid state microwave sources are configured to be coupled to the plasma chamber through the plurality of substrate holders.

20. A method of manufacturing synthetic diamond material using a chemical vapour deposition process, the method comprising:

providing a microwave plasma reactor according to any preceding claim;

locating a substrate over the substrate holder;

feeding microwaves into the plasma chamber;

feeding process gases into the plasma chamber; and

forming synthetic diamond material on the substrate.