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(54) Title: HIGH VOLTAGE ISOLATION OF AN INDUCTIVELY COUPLED PLASMA ION SOURCE WITH A LIQUID THAT IS NOT ACTIVELY PUMPED

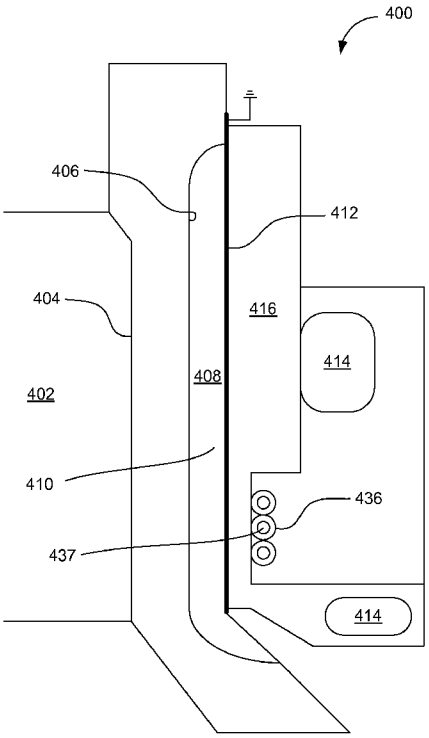

FIG. **4**

(57) Abstract: An inductively-coupled plasma source for a focused charged particle beam system includes a plasma chamber and a fluid that is not actively pumped surrounding the plasma chamber for providing high voltage isolation between the plasma chamber and nearby parts which are at ground potential, such as a conductive shield. One or more cooling devices cool the plasma chamber by using evaporative cooling and heat pipes to dissipate the heat from the plasma chamber into a surrounding environment.

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AMENDED CLAIMS
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1. A charged particle beam system, comprising:

a plasma source having:

a plasma chamber having a wall composed of a dielectric material, the wall having an interior surface and an exterior surface;

a conductor coiled at least one time around the plasma chamber;

a fluid surrounding and in thermal contact with at least a portion of the plasma chamber, in which the fluid is not actively pumped; and

a source electrode for electrically biasing the plasma to a high voltage;

one or more focusing lenses for focusing charged particles from the plasma source onto a sample; and

at least one heat pipe containing a dissipating fluid, a portion of the at least one heat pipe is in thermal contact with the fluid such that heat from the fluid can dissipate through the at least one heat pipe to cool the fluid, said dissipating fluid being separate from the fluid surrounding and in thermal contact with at least a portion of the plasma chamber.

2. The charged particle beam system of claim 1 in which a portion of the fluid is positioned between the plasma chamber and the conductor.

3. The charged particle beam system of claim 1 in which the fluid has a dielectric constant greater than 5.

4. The charged particle beam system of claim 1 in which the fluid comprises water or a fluorine compound.

5. The charged particle beam system of claim 1 further comprising a conductive shield positioned between the plasma chamber and the conductor, at least a portion of the fluid positioned between the plasma chamber and the conductive shield.

6. The charged particle beam system of claim 5 further comprising at least one cooling device for cooling the fluid.

7. The charged particle beam system of claim 6 in which the at least one cooling device comprises a thermoelectric cooler.

8. Cancelled.

9. The charged particle beam system of claim 1, further comprising a cooling fin in thermal contact with the at least one heat pipe, the cooling fin for dissipating heat from the at least one heat pipe and transferring the heat into a surrounding environment.

10. Cancelled.

11. A method of maintaining a plasma source, comprising:

providing a plasma chamber for containing a plasma;

providing radio frequency energy to the plasma chamber from a radio frequency coil;

providing a conductive shield between the coil and the plasma chamber; and

providing a fluid between the conductive shield and the plasma chamber; wherein the fluid provides high voltage isolation of the plasma chamber and the fluid is not actively pumped.

12. The method of claim 11 further comprising providing at least one cooling device in thermal contact with the plasma chamber for cooling the plasma chamber..

13. The method of claim 12 in which providing at least one cooling device comprises providing a cooling tube for circulating a cooling fluid or a thermoelectric cooler.

14. The method of claim 11 in which providing a fluid between the conductive shield and the plasma chamber comprises providing water or a fluorine compound.

15. The method of claim 11 further comprising providing a heat pipe for cooling the plasma chamber, in which a pojtjon of the heat pipe is in thermal contact with the fluid.

16. The method of claim 15 in which a portion of the fluid between the conductive shield and the plasma chamber is evaporated to produce a vapor, the heat from the vapor being dissipated by the heat pipe and transferred to a surrounding environment to cool the plasma chamber.

17. A method of providing high voltage isolation to a plasma source of a charged particle beam system, comprising:

directing energy to maintain a plasma in a plasma chamber;

conducting heat from the wall of the plasma chamber to a fluid, a portion of the fluid in thermal contact with the wall of the plasma chamber; and

cooling the fluid by evaporating a portion of the fluid by heat from the plasma chamber creating a vapor, the heat from the vapor being dissipated by a heat pipe into a surrounding environment, a portion of the vapor within the heat pipe condensing to its liquid state as the heat from the vapor is being dissipated into the surrounding environment and flows back into the jacket.

18. The method of claim 17 in which the fluid is not actively pumped.

19. The method of claim 17 in which the fluid is maintained in a jacket surrounding the plasma chamber, the jacket connected to the heat pipe such that a portion of the vapor rises through the heat pipe.

20. Cancelled.