

ABSTRACT OF THE DISCLOSURE

**CERAMIC SHOWERHEAD INCLUDING CENTRAL GAS INJECTOR FOR TUNABLE
CONVECTIVE-DIFFUSIVE GAS FLOW IN SEMICONDUCTOR SUBSTRATE
PROCESSING APPARATUS**

An inductively coupled plasma processing apparatus comprises a vacuum chamber, a vacuum source, and a substrate support on which a semiconductor substrate is supported. A ceramic showerhead forms an upper wall of the vacuum chamber. The ceramic showerhead includes a gas plenum in fluid communication with a plurality of showerhead gas outlets for supplying process gas to the interior of the vacuum chamber, and a central opening configured to receive a central gas injector. A central gas injector is disposed in the central opening of the ceramic showerhead. The central gas injector includes a plurality of gas injector outlets for supplying process gas to the interior of the vacuum chamber. An RF energy source energizes the process gas into a plasma state to process the semiconductor substrate. The flow rate of the process gas supplied by the central gas injector and the flow rate of the process gas supplied by the ceramic showerhead can be independently controlled.

FIG. 1