CLAIMS

1. A method for reducing ruthenium oxides on an extreme ultraviolet (EUV) photomask, comprising:

heating the EUV photomask with a ruthenium (Ru) capping layer with a top surface which has a Ru oxide layer to a range of 100 degrees Celsius to a thermal budget of the EUV photomask;

flowing a reducing agent gas into an EUV photomask processing chamber; and

pressurizing the EUV photomask processing chamber to a process pressure to increase a reducing reaction between the reducing agent gas and the Ru oxide layer on the Ru capping layer.

2. The method of claim 1, wherein the process pressure is from zero to 150 psi.

3. The method of claim 1, wherein the process pressure is from zero to 1500 psi.

4. The method of claim 1, wherein the EUV photomask processing chamber is a cylindrical chamber and the process pressure is from zero to 2500 psi.

5. The method of claim 1, wherein the process pressure is obtained by regulating a flow of the reducing agent gas into the EUV photomask processing chamber and effluent gases out of the EUV photomask processing chamber.

6. The method of claim 1, wherein the reducing agent gas is carbon monoxide gas, methane gas, or hydrogen gas.

7. The method of claim 1, further comprising:

flowing a carrier gas along with the reducing agent gas, wherein the carrier gas reduces volatility of high concentrations of explosive reducing agent gases.

8. The method of claim 1, wherein the thermal budget of the EUV photomask is 150 degrees Celsius.

9. An apparatus for reducing ruthenium (Ru) oxides on an extreme ultraviolet (EUV) photomask, comprising:

an EUV photomask processing chamber with a photomask support body attached to a photomask support, the photomask support body supporting an EUV photomask when present;

a reducing agent gas supply fluidly connected to the EUV photomask processing chamber;

a heater electrode in the photomask support body that is configured to heat the EUV photomask when present to a range of 100 degrees Celsius to 150 degrees Celsius;

a first valve that controls a reducing agent gas that enters into the EUV photomask processing chamber;

a second valve that controls effluent gases that exit the EUV photomask processing chamber; and

a controller that regulates the first valve and the second valve to adjust a pressure inside of the EUV photomask processing chamber, wherein the pressure is adjustable from zero psi to 2500 psi and is adjusted, by the controller, to control a reduction rate to reduce Ru oxides on a Ru capping layer on the EUV photomask.