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Selective etching of Mo/HfO_2 in inductively coupled Cl_2/O_2 plasmas for gate stack patterning

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In this study, we investigated the etching characteristics of Mo and HfO_2 single layers and Mo/HfO_2 stacked structure for metal electrode/high-*k* gate stack patterning in Cl_2/O_2 inductively coupled plasmas and the effects of O_2 addition on the etch rates and etch selectivity of the Mo to the HfO_2 layer. By controlling the process parameters such as the Cl_2/O_2 flow ratio, the top electrode power and the dc self-bias voltage (V_{dc}), the Mo/HfO_2 etch selectivity as high as ≅ 67 could be obtained. Addition of O_2 gas to the Cl_2/O_2 chemistry improved the Mo/HfO_2 etch selectivity because the O_2 gas in a certain flow ratio range reduced the HfO_2 etching reactions due to less chlorination of Hf but enhanced the Mo etch rate presumably due to effective formation of highly volatile Mo-O-Cl etch by-products. We could confirm the Mo selective etch to the HfO_2 in Mo/HfO_2 stacked structure during overetch time without no loss of HfO_2 layer.