S-P18

DC and RF Characteristics of HfO_2 in Metal-Insulator-Metal Capacitor

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Research on the development of high-k insulators in MIM capacitor, which is an essential component in silicon RF devices and mixed-signal integrated circuits, has attracted great attention. The purpose of this work is to investigate the feasibility of HfO_2 as an insulating film in MIM capacitors. HfO_2 films were deposited by the ALD method on the (100) p-type Si/SiO_2(~4m)/Ti/Pt substrates at 300 ^oC. The bottom electrode of Ti/Pt was prepared by sputtering, where Ti was employed as an adhesion layer and Pt was used to improve the conductibility of the electrode. The different sizes of capacitor (40×40, 50×50, 60×60, 70×70, 80×80, 90×90, and 100×100 m) were investigated to confirm the capacitance scalability. The HfO_2 film deposited by ALD is amorphous, which is desirable to improve the electrical characteristics. A capacitance density of 12.6 fF/um^2 and a dielectric constant of ~ 21 were extracted for 15 nm HfO_2 film, which is suitable for MIM capacitor application. Asymmetric *J-V* characteristics were obtained due to the asymmetric MIM capacitor structure with thedifferent Schottky barrier heights at the electrode interfaces. We have investigated the DC and RF characteristics of Si/SiO_2(~4m)/Ti/Pt-HfO_2-Al metal-insulator-metal (MIM) devices. We demonstrate in this work that the MIM capacitors with high-*k* HfO_2 films result in the better DC and RF properties than those obtained using either SiO_2 or Si_3N_4. Both high capacitance density and small frequency-dependent capacitance reduction were observed in the MIM capacitors in which HfO_2 was employed for an insulator.