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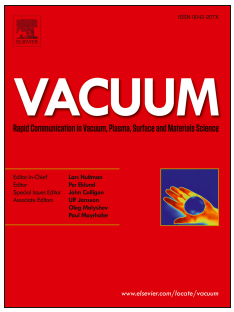

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Microstructural, surface and interface properties of zirconium doped HfO_2 thin films grown by RF co-sputtering technique

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Abstract

$Hf_{1-x}Zr_xO_2$ gate dielectric thin films were deposited on Si (100) substrates by RF reactive co-sputtering with the variation in the RF power of zirconium target. The compositional, morphological, structural and optical properties of $Hf_{1-x}Zr_xO_2$ films with various Zr content are systematically investigated by X-ray photoelectron spectroscopy, scanning electron microscopy, X-ray diffraction and Raman spectroscopy, respectively. The electrical properties of the co-sputtered thin films were studied by capacitance-voltage and current density-voltage measurements. The Zr content in sputtered $Hf_{1-x}Zr_xO_2$ film was found to be increased up to 19 % at a RF power of 90 W. With the increase in Zr content, the enhancement in the crystalline behaviour of co-sputtered film is observed. FESEM micrographs depicted the increase in the grain size with rise in RF power of Zr target. The major generated phase of $Hf_{1-x}Zr_xO_2$ film is the zirconium-substituted monoclinic phase as revealed from Raman spectroscopy study. The oxide (Q_{ox}) and interface charge density (D_{it}) were estimated from the high frequency (1 MHz) Capacitance–voltage curve. The D_{it} has a minimum value for the film deposited at a RF power of 45 W for Zr target, which is due to the reduction of unsaturated bonds and structural relaxation at the $Hf_{1-x}Zr_xO_2$/Si interface.

Keywords: High-k gate dielectrics; $Hf_{1-x}Zr_xO_2$ films; Reactive co-sputtering; XPS; Surface and interface characterizations

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