Characterization of $Hf_{1-x}Zr_xO_2$ Gate Dielectrics with 0 <= x <= 1 Prepared by Atomic Layer Deposition for Metal Oxide Semiconductor Field Effect Transistor Applications

Chen-Kuo Chiang,吳建宏,Chin-Chien Liu,Jin-Fu Lin,Chien-Lun Yang,Jiun-Yuan Wu,Shui-Jinn Wang
Electronics Engineering
Engineering
rossiwu

Abstract

In this work, we investigated the influence of incorporating zirconia (ZrO_2) in HfO_2 gate dielectric on the electrical properties and reliability of
n-channel metal oxide semiconductor field effect transistors (nMOSFETs).
Detailed film physical, chemical and optical properties of Hf1 x $ZrxO_2$
as a function of Zr content were studied using high resolution
transmission electron microscopy (HR-TEM), angle resolved X-ray photoelectron
spectroscopy (AR-XPS), and spectroscopic ellipsometer (SE). Compared to HfO_2, Hf1
x $ZrxO_2$ provides not only higher k values for further
equivalent oxide thickness (EOT) scaling but also lower
capacitance–voltage (C–V) hysteresis, lower threshold voltage (Vt) shift (Vt), and higher
time-to-failure (TTF) lifetimes. Improved TTF lifetime of as high as three
orders of magnitude and 35% lower Vt shift were achieved from the
Hf1 x $ZrxO_2$ gate stack with x ¼ 0:8. The improved reliability of the Hf1 x $ZrxO_2$ gate dielectric is attributed to the reduced charge trapping in the
Hf1 x $ZrxO_2$ gate dielectric caused by the ZrO_2 incorporation.

Keyword：ZrO_2, HfO_2, ALD