Sains Malaysiana 48(6)(2019): 1195–1199
http://dx.doi.org/10.17576/jsm-2019-4806-06

Effects of Post-Deposition Annealing Temperatures on the Composition of Interfacial Layer at Germanium (Ge) /Aluminium Oxide (Al_2O_3)

(Kesan Suhu Penyepuhlindapan Pasca Pemendapan ke atas Komposisi Antara Muka Lapisan Oksida Germanium (Ge)/Aluminium (Al_2O_3))

Siti Kudnie Sahari*, Nik Amni Fathi Nik Zaini Fathi, Azrul Azlan Hamzah, Norsuzailina Mohamed Sutan, Zaidi Embong, Suhana Mohamed Sultan, Muhammad Kashif, Marini Sawawi, Lilik Hasanah, Rohana Sapawi, kuryati Kipli, Abdul Rahman Kram & Nazreen Junaidi

ABSTRACT

The understanding of chemical bonding structure of high k dielectrics/Germanium (Ge) interface is upmost importance in order to form a good quality dielectric/Ge interface in fabricating Ge metal oxide semiconductor field effect transistor (MOSFETs). In addition, there is still no detail explanation on the interfacial growth of dielectrics/Ge under the influenced of different temperature of post deposition anneal. In current work, the effects of post deposition anneal (PDA) temperature between 400°C and 600°C on the chemical composition of interfacial layer between Ge and Al_2O_3 were examined by X-ray photoelectron spectroscopy (XPS). Investigation on thermal stability and structural characteristics for gate structure of Al_2O_3 dielectric grown on Ge by RF sputtering was done by analyzing X-ray photoelectron spectroscopy (XPS) spectra. It is observed that the oxygen deficient region in interfacial layer (IL) is enhanced rather than fully oxidized Al_2O_3 with increased PDA temperatures. These undesired phenomena caused shrinkage of IL at Ge/Al_2O_3 interface at higher temperature of 600°C.

Keywords: Al_2O_3; germanium; interfacial layer; post deposition anneal

ABSTRAK

Pemahaman tentang struktur ikatan kimia yang tinggi dielektrik/antara muka Germania (Ge) adalah sangat penting untuk membentuk antara muka dielektrik/Ge berkualiti baik dalam fabrikasi Ge kesan medan transistor logam oksida semikonduktor (MOSFETs). Di samping itu, masih belum ada penjelasan terperinci mengenai pertumbuhan antara dielektrik/Ge di bawah pengaruh suhu yang berlainan bagi pemanasan pasca sepuh lindap. Penyelidikan kesan suhu pemendapan pasca sepuh lindap (PDA) antara 400°C dan 600°C pada komposisi kimia lapisan antara antara Ge dan Al_2O_3 diperiksa oleh spektroskopi fotoelektron x-ray (XPS). Dalam makalah ini, kami mengkaji kestabilan terma dan pencirian struktur untuk struktur gerbang Al_2O_3 dielektrik yang ditanam di Ge oleh percikan RF oleh spektroskopi fotoelektron x-ray (XPS). Difahamkan bahawa rantau kekurangan oksigen dalam lapisan antara muka (IL) ditingkatkan daripada Al_2O_3 sepenuhnya teroksida dengan suhu PDA yang meningkat. Fenomena yang tidak diingini ini menyebabkan pengecutan IL pada antara muka Ge/Al_2O_3 pada suhu lebih tinggi 600°C.

Kata kunci: Al_2O_3; Ge; lapisan antara muka; pos pemendapan rawatan haba

Introduction

Germanium(Ge) can be used to replace Silicon (Si) as a channel because it has four times higher hole mobility and two times higher electron mobility than Si (Wallace et al. 2009). The replacement of Si by Ge reopens the space for high-k dielectric Ge metal oxide semiconductor field effects transistors (MOSFETs) development. However, besides fabrication handling of Ge as a channel, the quality of the surface and interface between high k and Ge is still a main technological issue that must be overcome for development of MOSFETs. The poor quality of Ge/dielectrics with high interface states density and high interface roughness have been shown on the high permittivity dielectrics such as HfO_2, ZrO_2, on Ge substrate (Han et al. 2013; Ngai et al. 2000; Wu et al. 2005). Therefore, to improve the quality of interface between high k and Ge, the implementation of IL between high k and Ge has been proposed (Shang et al. 2007). For the case of Aluminum oxide (Al_2O_3), the formation of interfacial layer (GeO_x) between Ge and Al_2O_3 resulted in low defect states density ($10^{-11}cm^{-3}$) (Zhang et al. 2013). To resolve the issues of surface and interface between high k and Ge, the selection of annealing ambience during the fabrication is to be taken into account. Previous research showed that the selective passivation of low interface traps can be influenced under multiple conditions of annealing (Zhang et al. 2015). In addition, surface treatment with HBr, HCl, HF, H_2S-based have been used to obtain a well passivated at Ge and high k interface (Bai-Qing et al. 2012; Elshochta et. al. 2006).