Growth kinetic and composition of the interfacial layer for RF sputtering Al_2O_3 layer on germanium

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Abstract

Purpose – The quality of GeOx–Ge interface and the equivalent oxide thickness (EOT) are the main issues in fabricating high-k/Ge gate stack due to the low-k of GeOx interfacial layer (IL). Therefore, a precise study of the formation of GeOx IL and its contribution to EOT is of utmost importance. In this study, the GeOx ILs were formed through post-oxidation annealing of sputtered Al_2O_3 on the Ge substrate. The purpose of this paper is to report on growth kinetics and composition of IL between Al_2O_3 and Ge for HCl- and HF-last Ge surface.

Design/methodology/approach – After wet chemical cleaning with HCl or HF, Al_2O_3 was grown onto the Ge surface by RF sputtering. Thickness and composition of IL formed after post-anneal deposition at 400°C in dry oxygen ambience were evaluated as a function of deposition time by FESEM and characterized by X-ray photoelectron spectroscopy, respectively.

Findings – It was observed that the composition and thickness of IL were dependent on the starting surface and an aluminum germinate-like composition was formed during RF sputtering for both HF- and HCl-last starting surface.

Originality/value – The novelty of this work is to investigate the starting surface of Ge to IL growth between Al_2O_3/Ge that will lead to the improvement in Ge metal insulator field effect transistors (MISFETs) application.

Keywords Interfacial layer, HCl, Germanium, Germanium oxide, HF, X-ray photoelectron spectroscopy

Paper type Research paper

1. Introduction

Germanium (Ge) becomes a candidate to replace silicon (Si) because it has four times the hole mobility and twice the electron mobility than Si for metal oxide field effect transistors (MOSFETs) application (Shang *et al.*, 2010; Sze, 1981; Saraswat *et al.*, 2005). Developing a suitable gate stack on Ge has become one of the remaining challenges that Ge-based devices must overcome if they are to replace Si as channel material (Goley and Hudait, 2014). There are two important technological requirements for the gate stacks to be solved to realize the high performance of Ge MOSFETs; sufficient passivated MOS interface with low interface trap density (D_{it}) and thin equivalent oxide thickness (EOT) (Shang *et al.*, 2007; Hamzah *et al.*, 2007, 2013). To achieve thin EOT, high-k dielectrics become very attractive candidates as a dielectric material. Many extensive researches have been done on several high-k candidates such as HfO_2, ZnO_2, rare-earth materials, Al_2O_3 and etc. (Matsubara *et al.*, 2008; Nakakita

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