Effect of Substrate Orientation on the Growth of Germanium Oxide in Dry Oxygen Ambience

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Abstract. The present investigation deals with the effect of substrate orientation effect on the growth of thermally oxidized Ge. The thermal oxidation was performed at temperature between 375 and 550 ℃ in dry oxygen ambient under atmospheric pressure. The thickness of thermally oxidized Ge films was measured by spectroscopic ellipsometry and the chemical bonding structures were characterized by using x-ray photoelectron spectroscopy (XPS). No orientation dependence was observed for the oxidation at temperature of 375 ℃ while for oxidation at 490 and 550 ℃, Ge oxidation and GeO desorption rate of (100) orientation yield higher rate than (111). The larger atomic space of (100) orientation explains the higher oxidation and desorption rate at Ge surface.

1. Introduction

Germanium (Ge) is one of the alternative channels for replacing Silicon (Si) for metal oxide semiconductor Field Effects Transistors (MOSFETs) because of higher carriers mobility than Si [1-3]. However, the thermodynamic instability at the high k/Ge interface is the most critical issue that must be overcome to realize a superior metal insulator semiconductor (MIS) [1-3]. On the other hand, an appropriate choice of substrate orientation and channel orientation for high performance Ge MOSFET are very important to determine the band structure of material and transport performance of the devices [4]. Several existing experimental reports showed unconformity with simulation results and inconsistency results among the group of researchers especially on the comparison between (100) and (110) surface orientation on the performance trend of Ge MOSFETs [5]. There was a report reported that Ge(110) shows the highest hole mobility for Ge MOSFETs application while another report showed the Ge(100) is the best substrate for MOSFETs application [6-7]. Moreover, Quan-Xin et al. reported that no orientation dependence between Ge (100) and (111) on the GeMOSFETs performance [8]. The independency between Ge (100) and Ge (111) on the performance of the GeMOSFETS is still in the open question.

Therefore, in this report, we try to clarify the independency between Ge(100) and Ge(111) by thermal oxidation. The substrate orientation dependence is investigated on the growth of Ge oxide at temperature between 375 and 550 ℃.

2. Experimental procedure