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Dominant growth of higher manganese silicide film on Si substrate by introducing a Si oxide capping layer

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Abstract: A surfacant free growth method was proposed to get thick $MnSi_{\sim 1.7}$ film by exposure of Si(111) substrates to $MnCl_2$ vapor in quartz ampoules. Prior to the growth of silicide film, an amorphous nano SiO_x capping layer was introduced on the Si substrate. The capping layer changes the elemental diffusion flux to the reaction interface and facilitates the growth of single phase $MnSi_{\sim 1.7}$ film. Optical absorption spectrum demonstrates the existence of a direct band gap~ 0.78 eV, which agrees well with the theoretical one obtained by density functional theory modeling.

Keywords: $MnSi_{\sim 1.7}$; Multi-scale growth; Optical property; Band gap

1. Introduction

It is significant to study the metal silicides, which has theoretical and practical significance to develop environmental friendly materials and improve the sustainability of electronics industry[1-2]. Higher manganese silicide (HMS) has attracted much attention in recent years due to high conductivity and Seebeck coefficient [3]. $MnSi_{1.7}$ is a 3d transition metal semiconductor compound and has several kinds of super-structure phase with identical tetragonal subcell: Mn_4Si_7, $Mn_{11}Si_{19}$, $Mn_{15}Si_{26}$, $Mn_{26}Si_{45}$ and $Mn_{27}Si_{47}$, which are stable at high temperature. The atomic ratio of Si/Mn varies between 1.71 and 1.75 [3].

In previous studies, the growth of thin film manganese silicides have been reported by solid phase epiatxy(SPE), reactive deposition epitaxy(RDE), ion beam epitaxy and molecular beam epitaxy(MBE) [3-5]. According to the Mn-Si phase diagram, there exists a variety of Mn-Si compound phases. Thermodynamically, Mn_5Si_3 phase will form prior to other phase in Mn-Si system at a large temperature range (380 ~ 700 ^oC) [6]. Multi-phase formation always limits the

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