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PII: S0925-8388(17)33560-0

DOI: [10.1016/j.jallcom.2017.10.124](https://doi.org/10.1016/j.jallcom.2017.10.124)

Reference: JALCOM 43521

To appear in: *Journal of Alloys and Compounds*

Received Date: 15 August 2017

Revised Date: 7 October 2017

Accepted Date: 17 October 2017

Please cite this article as: S. Cao, Q. Wang, J. Hu, Z. Fu, K. Bai, G. Shao, G. Cao, Dominant growth of higher manganese silicide film on Si substrate by introducing a Si oxide capping layer, *Journal of Alloys and Compounds* (2017), doi: 10.1016/j.jallcom.2017.10.124.

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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 surfactant free growth method was proposed to get thick MnSi<sub>1.7</sub> film by exposure of Si(111) substrates to MnCl<sub>2</sub> vapor in quartz ampoules. Prior to the growth of silicide film, an amorphous nano SiO<sub>x</sub> 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<sub>1.7</sub> 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<sub>1.7</sub>; 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<sub>1.7</sub> is a 3d transition metal semiconductor compound and has several kinds of super-structure phase with identical tetragonal subcell: Mn<sub>4</sub>Si<sub>7</sub>, Mn<sub>11</sub>Si<sub>19</sub>, Mn<sub>15</sub>Si<sub>26</sub>, Mn<sub>26</sub>Si<sub>45</sub> and Mn<sub>27</sub>Si<sub>47</sub>, 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 epitaxy(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<sub>5</sub>Si<sub>3</sub> phase will form prior to other phase in Mn-Si system at a large temperature range (380 ~ 700 °C) [6]. Multi-phase formation always limits the

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