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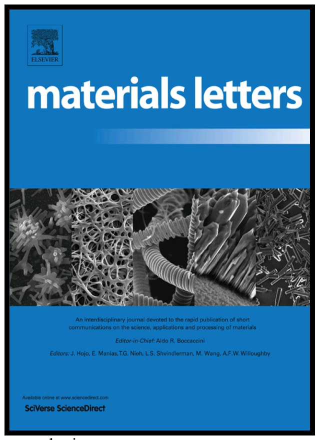


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# *Formation of large-grain crystalline germanium on single layer graphene on insulator by rapid melting growth*

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**Abstract**

We demonstrate the crystallization of thermally deposited amorphous germanium (Ge) microstrips on single layer graphene (SLG) by rapid melting growth. Lateral growth of large grain crystalline Ge was successfully obtained over entire microstrip structure. SLG has shown its capability to suppress the spontaneous nucleation in the melting Ge, where no or less intermixing of C and Ge atoms has been detected. The interaction of C atoms from the graphene and Ge atoms at the interface is the possible reason for the observation of large compressive strain generated in the Ge strip grown on SLG. This technique provides an innovative breakthrough towards the realization of single-crystalline Ge-on-insulator (GOI) structure on SLG to facilitate the next-generation ultra-large-scale integrated circuits (ULSIs) with multifunctionalities.

**Keywords:** Semiconductors; Carbon materials; Germanium; Germanium-on-insulator; Single layer graphene; Rapid melting growth



## 1. Introduction

As miniaturization of the silicon (Si) transistors becomes increasingly challenging, increased performance can only be achieved by integrating multifunctional materials on Si platform. Recently, the concept of advanced heterogeneous integration on Si platform was proposed by Takagi *et al*. that will enable the realization of a so-called “More than Moore” technology [1]. Here, the incorporation of germanium (Ge) that possesses higher electron and hole mobilities than that of Si is attractive [2] for not only to enhance the performance of complementary-metal-oxide-semiconductor (CMOS) circuits [3] but also to facilitate the present ultra-large-scale integrated circuits (ULSIs) with various functionalities where Ge can be also used to fabricate various kinds of functional devices, such as optical devices [4], photodetectors [5] and solar batteries [6]. Also the lattice similarity of Ge with the III-V semiconductor, such as GaAs and metallic silicide, such as $Fe_3Si$ enables the use of Ge as a buffer layer for the integration of III-V semiconductor and metallic silicide on Si platform [7]. By considering these potential applications, the formation of single-crystalline Ge-on-insulator (GOI) structure needs to be realized on Si substrate. However, the extremely large lattice mismatch between Ge and insulator prevent the direct growth of crystalline Ge on insulator. One of promising technique in growing crystalline GOI structure is to introduce a so-called buffer layer or template layer for the relaxation of lattice mismatch during the crystallization process. Meanwhile, the crystallization of Ge can be achieved by a rapid melting growth [8-13].

Graphene, a two-dimensional hexagonal network of carbon atoms formed by making strong triangular σ-bonds of the $sp^2$ hybridized orbitals, has been employed as the potential