Dramatic effects of Sn addition on Ge crystallization

Research on novel materials to replace Si has been actively pursued for sustainable improvement of electronic devices. Ge has attracted attention as the most promising candidate for next-generation material because it has a higher carrier mobility than Si for both electrons and holes and is compatible with conventional Si processing. In addition, Ge has a lower crystallization temperature and grain-boundary potential than Si. These properties have motivated researchers to directly synthesize polycrystalline Ge on various substrates, such as Si, glass, and plastic sheets, to fabricate advanced thin-film transistors for three-dimensional integrated circuits or high-performance mobile terminals.

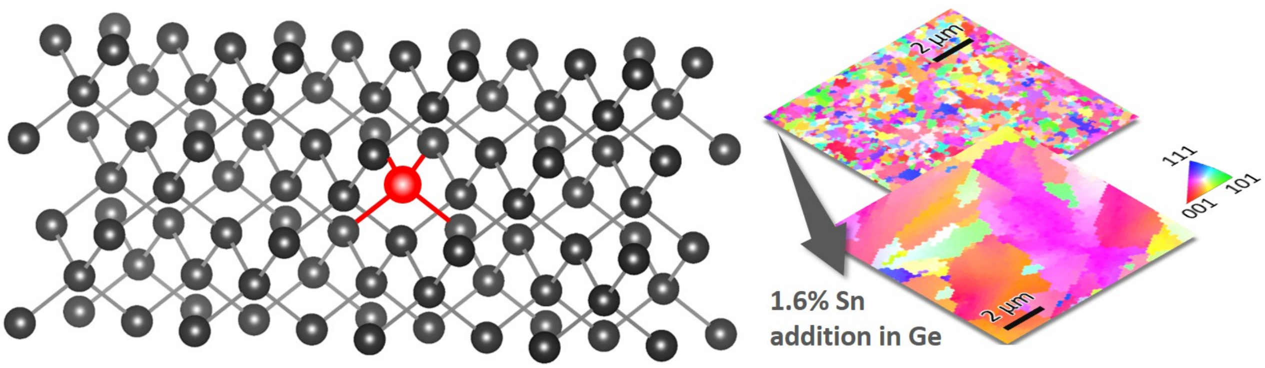

Fig. 1. Sn addition in a Ge thin film, which dramatically enlarges Ge grains.

Solid-phase crystallization is a simple polycrystalline synthesis method that consists only of amorphous thin film deposition and heat treatment. This paper demonstrates that the addition of only a few percent Sn in amorphous Ge dramatically improves the properties of solid-phase-crystallized Ge. The effects of the Sn addition are the following three: (i) increasing the grain size of polycrystalline Ge by one order of magnitude (Fig. 1), (ii) decreasing the grain boundary potential, and (iii) passivating the defect-induced acceptors in Ge. Owing to these characteristics, the Sn-doped Ge layer exhibits the highest recorded hole mobility of crystalline semiconductors directly grown on insulators. The addition of a few percent As and Sb in Ge also improves the grain size of the solid-phase-crystallized Ge thin film. This phenomenon will be highly universal and applicable to various materials.

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