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Sn-related Group-IV semiconductor materials for electronic and optoelectronic applications

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Abstract

Application of Si nanoelectronics is widely growing from ultra-large scale integrated circuits to various functional, microelectromechanical, and optoelectronic systems. $Ge_{1-x}Sn_x$ is one of the most attractive materials in order to develop future Si nanoelectronics. $Ge_{1-x}Sn_x$ is expected to be stressor for realizing biaxially tensile or uniaxially compressive strained Ge for higher mobility channel than conventional strained Si. Also, $Ge_{1-x}Sn_x$ with a high Sn content larger than 10 % promises to be direct transition semiconductor with lowering the conduction band edge at the Γ point. That leads to realizing optoelectronic applications and high mobility channel with a small effective mass of electron at the Γ point. In addition, $Ge_{1-x-y}Si_xSn_y$ ternary alloy is expected to be electronic and optoelectronic materials because of its advantage that the energy band structure can be controlled independently on the lattice constant.

Challenges of Sn-related group-IV materials are suppressing the Sn precipitation from the substitutional site, controlling crystalline defects and strains, and engineering the energy band structure and electronic properties. We have developed the epitaxial growth and/or crystallization of $Ge_{1-x}Sn_x$ and $Ge_{1-x-y}Si_xSn_y$ thin films on various substrates such as Si, Ge, InP, and insulators. We have also investigated the behavior of Sn, dopant atoms, and point defects in the Sn-related semiconductors. In this presentation, we demonstrate recent results of growth and properties of Sn-related group-IV materials for future Si nanoelectronics applications.

Biography

Osamu Nakatsuka has completed his Ph.D at the age of 27 years from Nagoya University and postdoctoral studies from Kyoto University. He is the associate professor of the Department of Crystalline Materials Science, Graduate School of Engineering, Nagoya University. His research area is related to group-IV semiconductor technology, thin film engineering, and surface/interface science. He has published more than 70 papers in international journals and serving as an editorial board member of Japanese Journal of Applied Physics.