(Invited) Electrically Pumped GeSn/SiGeSn Lasers

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Abstract

Si-based photonic integrated circuits, where optical components are monolithically integrated on Si Integrated Circuits, are expected to dominate the future information and communication technology infrastructure. The Si photonic (SiPh) technology, consisting of both active- and passive components, is already widely used in a wealth of applications, ranging from datacom to detection systems. Recently, SiPh entered the technology platform for cryogenic applications in the emerging fields of integrated quantum technologies, optical computing, and artificial intelligence. Nonetheless, an efficient, electrically pumped light source that can be manufactured using solely group-IV semiconductors remains a major challenge. The novel GeSn and SiGeSn semiconductors obtained by the substitutional incorporation of Sn, a semi-metal, into the Ge lattice, offer a few advantages over other group-IV semiconductor alloys: by properly selecting the alloy composition and epitaxial strain, these materials are turned into fundamental direct bandgap semiconductors. This property normally missing in Group IV makes the (Si)GeSn system very attractive for efficient light sources. Using this material system, major milestones in group-IV lasing were reached in recent years like optically pumped bulk and Multi-Quantum Wells (MQW) lasers working up to room temperature.

Building on an extensive experimental activity on optically pumped GeSn heterostructures, here we will discuss electrically pumped lasing. The accent is put on two key features: CW operation and low threshold currents. Both of these milestones are simultaneously reached in SiGeSn/GeSn MQW micro disk cavity laser diodes. We will also discuss the material design in SiGeSn/GeSn heterostructures and a possibility of strain engineering to push the electrically pumped lasing to room temperatures.